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Edited for the Council by J. LAURENCE PRITCHARD, Associate Fellow.

All communications should be addressed to the Editor.

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Notices of the Royal Aëronautical Society.

Elections.

The following members were elected at a Council meeting, held on May 18th, in the various grades as shown:—

Fellow.—R. McKinnon Wood.

Associate Fellows.—F. P. H. Beadle, Captain H. R. Gillman, A. A. Grone, G. Ham, Lieutenant P. H. Harrower, Squadron Leader R. M. Hill, M.C., A.F.C., Captain S. W. Hiscocks, V. I. Johnston, Major F. R. McMahon, F. Murphy, B.Sc., Wing Commander H. W. S. Outram, C.B.E.

Members.—A. Brown, R. L. Carton, D. A. Gortley-Jones, Second Lieutenant S. Kirtekar, Flying Officer G. W. Longstaff, H. P. Marsh, J.P., Flying Officer F. A. Norton, G. A. Parsons, Lieutenant J. H. L. Purkess.

Associate Members.—C. G. Brown, G. P. Ford, P. N. Rao.

Students.—A. N. Jackson, O. E. Simmonds.

Foreign Member.—Commander E. S. Land, U.S.N., Assistant U.S. Naval Attaché.

Wilbur Wright Lecture.

The annual Wilbur Wright Lecture will take place at the Central Hall, Westminster, on Tuesday, June 22nd, at 8.30 p.m., when Commander J. C. Hunsaker, U.S.N. (Corps of Constructors), of the U.S. Navy Bureau of Construction and Repair, will read an important paper on "Naval Architecture in Aeronautics." Friends of members are invited to attend and tickets for reserved seats will be forwarded on application to the Secretary. H.R.H. Prince Albert has graciously consented to take the chair and has signified his intention of attending a Council dinner to be held beforehand. It is hoped that members will assist in securing a representative attendance by forwarding to the Secretary the names of those they wish to be invited.

Lectures.

The Council have decided that the next Lecture Session shall be strictly limited to the months of October, 1920, to March, 1921. It is also proposed to try the experiment of holding the meetings at 5.30 in the afternoon instead of in

the evening as heretofore. In view of this it is proposed to have only a précis of each paper read at the meeting, the full paper being available beforehand, occupying not more than half-an-hour, in order that the remaining hour may be devoted to a free and open discussion. On suitable occasions it is also proposed to adopt the principle of having the précis of two lectures read at the same meeting.

Annual Dinner.

The Council have decided that it will be in accordance with the wish of members that a Society dinner should be held annually in order to afford members an opportunity of meeting, which they might not otherwise have. It is proposed to hold the first of these annual dinners during the month of October in the present year. Details will be announced later.

Examinations Committee.

The Examinations Committee have drawn up a preliminary report as to the qualifications for Associate Fellowship which should be accepted in lieu of examinations to be held by the Society. The qualifications have for this purpose been divided under three heads:—(*a*) General education, (*b*) technical qualifications, (*c*) aeronautical qualifications.

The preliminary question under (*b*) as to whether the technical qualification, apart from aeronautical qualification, should be confined to engineering knowledge or whether proficiency in science and mathematics should be accepted, was referred to Council, who decided in favour of the latter. The general principle adopted is to suggest the acceptance of degrees, certificates or diplomas of Universities or Colleges approved by the Council, together with the fixing of an age limit and a certain number of years' experience in the application of science to aeronautics.

It is recommended that Fellowship should remain a matter of election by the Council, subject to certain qualifications of age and experience similar to those for Associate Fellowship.

Subscriptions.

Although a considerable amount of increased subscriptions for the current year have been received, there are still a number of members who have not forwarded this. It is desired to appeal to any members who may object to the increase to study the balance sheet, which appeared in the May issue of the Journal, when the reasons for the increase will become apparent. It will, it is hoped, be realised that the Society must inevitably share in the effects of the present quietude in the aeronautical world and that it must therefore rely upon the support of members for a continuance of its activities. Every effort is being made to cut down all except essential expenses.

Aero Show.

Members are reminded that the International Aero Show will be held at Olympia from July 9th to July 20th, inclusive. It is hoped that arrangements will be made for a room to be available for the use of members of the Society.

W. LOCKWOOD MARSH, *Secretary.*

PROCEEDINGS.

ELEVENTH MEETING, 55th SESSION.

The Eleventh Meeting of the Fifty-Fifth Session was held in the Hall of the Royal Society of Arts on Wednesday, April 14th, 1920, Major-General Swinton (Controller of Information, Air Ministry) presiding.

The CHAIRMAN said it was his privilege and pleasure to introduce the Lecturer, Captain P. D. Acland, who was manager of the Aviation Department of that firm which, during the war, and especially latterly, in connection with the subject of that evening's lecture, had done so much for British aviation. He would not follow the example of a chairman at another meeting, who had spent three-quarters of an hour in introducing him (General Swinton) and had left him only a quarter of an hour for his speech. He would therefore ask the Lecturer to proceed with what he had to tell them.

Captain P. D. ACLAND then delivered the following Lecture :—

TRANS-CONTINENTAL FLYING.

The object of this paper is to give a short *resumé* free from technical details of the principal flights undertaken by us during the past year; to give you our reasons for undertaking them; to describe the general organisation and points of interest in each flight; the conclusions we arrived at; and finally to deal shortly with the costs of flying.

At the outset I shall have to apologise for mentioning the name of our machine and for using it as a basis of cost, but I am sure you will forgive this as we have no personal or practical knowledge of other types.

In November, 1918, the industry was faced with many serious problems arising out of the sudden and almost unexpected cessation of hostilities. The tremendous impetus of the Allied offensive in the later stages of the war had not given the manufacturer time to spare for the consideration of post-war problems except in a very general way. The affairs of the moment were paramount—namely, production. Our minds, therefore, were turned more towards manufacture and production than operation. It is necessary, I consider, to lay stress on this point of view because we had become accustomed to think in hundreds of machines and engines, and in a moment had to alter our ideas to visualise a reduced output from our factories which would be gradually increased in time to fulfil our ambition of seeing vast fleets of commercial aircraft carrying merchandise and passengers to all corners of the earth.

This was the position then soon after the Armistice—our orders were considerably curtailed, in some cases wiped out. Arrangements were not complete for "peace products" to take up the surplus space lately employed in aircraft; new markets not found; agents not appointed; the censorship had prevented free intercourse with outside countries as to their needs for aircraft, neutral countries were unaware of the details of the technical advances at home. Thus there was an enormous amount of spade work to be done before we could begin to think of getting our factories put into active operation on any kind of peace production. The world eulogised aircraft, but demanded other forms of transport as their first need.

Again, the circumstances of war had given a rapid expansion to both military aeronautics and the industry far in advance of the ideas of legislation formulated prior to the war, when the operation of aircraft between countries was practically in the embryonic stage of spectacular performances only. Thus, at very short

notice, legislation had to be created, Air Navigation Rules formed, conventions signed and sealed between countries, before civil international traffic could commence. At the same time, hostilities had not ceased and permission could not be granted civilian firms to undertake anything more than test flights within their own aerodrome areas.

We owe a great debt of gratitude to Sir Frederick Sykes and the committees set up by him so promptly, who discussed and drew up those rules and regulations, now known as the Aerial Navigation Act—the law of the air! With minor modifications these regulations are standardised throughout the world. These committees were formed in the most broadminded sense and included members of our own industry so that, in this instance, the people commercially responsible for the use of aircraft were given an opportunity of putting forward their own opinions and suggestions, which I may say were in the majority of cases adopted.

However, this work could not be completed for many months. We felt that "something had to be done" to show the public that a virile industry existed. In this we were rendered great service by the Press, for very shortly after the Armistice the suggestion of flying the Atlantic was again brought forward, several firms sending parties and machines over to Newfoundland with the object of competing for the prize offered by the "Daily Mail," through the generosity and foresight of Lord Northcliffe.

This competition gave us something definite to go for. An opportunity was afforded to test out the reliability of British motors and the war machines intended for long distance work. Also, it gave a little breathing space to proceed with designs for commercial aircraft, which, as we all know, is a big problem. During the war design certainly improved to an almost startling degree, but the be all and end all of each and every military type was to fulfil, and if possible, surpass the requirements laid down by the Air Force for maintaining our supremacy in the air on the fighting fronts.

Thus the general trend of design was the cutting down of weight, uneconomical use of engines, undue wear and tear, etc. For commercial types we obviously required reliability, safety, economy in running, cheapness in manufacture, and ease of handling as opposed to the military requirements of maximum performance first and foremost, other qualities being attained to as great an extent as possible. Then again, the form of the commercial machine had to be considered, and investigations had to be made into the earning capacities of various designs.

With all this work, therefore, to undertake we came to the conclusion that it would be more than advisable to enter a machine for the Atlantic flight with a view to testing out our war-time construction, satisfying ourselves as to the engines we were standardising, and at the same time freeing the remainder of the staff for the tasks set them in the way of commercial progress.

The machine we selected for the flight was a standard Vickers "Vimy" Bomber, fitted with two Eagle VIII. Rolls-Royce engines, and may be described generally as a medium size aeroplane:—

Span	67ft. 0in.
Overall length	42ft. 8in.
Maximum height	15ft. 3in.
Gap	10ft. 0in.
Chord	10ft. 6in.

This size has been attained without excessively heavy loading, the weight per square foot of supporting surface being 9.4lbs. and weight per horse-power when fitted with two 350 h.p. engines 17.9lbs. The machine is stable, having a dihedral angle of 174° (or 3° on each side). The full speed near the ground is approximately 109 miles per hour, and when fully laden it will climb to 6,000 feet

in 25 minutes, giving a speed of 98 miles per hour at that height with engines all out.

In the military type four main petrol tanks are fitted with a capacity of 516 gallons, giving a range of 1,300 miles when cruising at 90 miles per hour.

The weight of machine empty is	6,890 lbs.
Petrol	3,680 ,,
Oil	260 ,,
Crew (three men)	540 ,,
Military load	1,130 ,,
Total weight	12,500 lbs.

The fuselage is constructed in two sections, the front part being made of steel tubes on which come all the heavy loads of the machine. The steel work is carried back as far as the rear spars, and the back half of the fuselage is constructed of McGruer section spars cross braced in the usual way with swaged steel tie-rods. The main plane spars are of box section, and built up of spruce and 3-ply wood bound with fabric. The interplane struts are of solid spruce, except in the case of the engine bays, where the struts are of steel tubes with wooden fairings. Each engine mounting is attached to four steel struts, an undercarriage of the ordinary double V-type is situated immediately below the engine mountings, the empenage is of the bi-plane type and is fitted with two K-shaped fins, two balanced rudders, and two balanced elevators. The petrol supply is maintained by two fan-driven petrol pumps with regulating valves to maintain a constant flow to a service tank, with overflow return to main tanks.

In giving particulars of this machine I wish to acknowledge our debt of gratitude to General Pitcher (then Controller of the Technical Department of the Air Ministry) and Colonel Alec Ogilvie, his very able Assistant, for their assistance and courtesy during the time we were designing and testing out this type of machine in 1917 and 1918.

The alterations necessary to enable this machine to fly from Newfoundland to Ireland were:—

Elimination of all armament.
Crew reduced from three to two.
Petrol capacity increased from 516 gallons to 865 gallons, sufficient for a range of 2,440 miles, or a margin of 30 per cent. over the minimum distance.
Front gunner's cockpit occupied by petrol and oil tanks.
Rear gunner's cockpit occupied by petrol tank.
Additional petrol tanks placed in rear half of fuselage. Tanks coupled up directly for equal consumption, in order to preserve balance.
Necessary alterations to petrol and oil piping system.
Total weight for military purposes, 12,500lbs.
Total weight for Trans-Atlantic flight, 13,500lbs. (approx.).

A wireless set was carried, having a range of about 240 miles, but unfortunately the shaft of the generator sheared about ten minutes from the start, and accordingly it was impossible to send any messages during the journey. We were unable to trace what exactly caused this breakage.

You will see from these details that, broadly speaking, the whole structure of the machine and engines was absolutely standard, with the exception that we simplified the petrol system which for war purposes has to be somewhat complicated for long distance aeroplanes, owing to the danger of the tanks being pierced.

The machine was flown by the end of April, 1919, shipped on the 4th May,

and flew from Newfoundland to Ireland on the 14-15 June, in less than three weeks from the time of its arrival in Newfoundland.

The staff sent to Newfoundland consisted of the following:—

Pilot—Captain Sir John Alcock, K.B.E., D.S.C.
Navigator—Lieutenant Sir A. Whitten Brown, K.B.E.
Our Weybridge Works Superintendent—Mr. P. Maxwell Muller, M.B.E.
One foreman in charge.
One erector.
Two riggers.
Four carpenters.
Mr. Platford representing Messrs. Rolls-Royce, Ltd.
Two engine mechanics.

All took sleeping bags, personal luggage, and appropriate tool kits.

Machine Spares.—On a flight of this nature it was obviously useless to carry any spares in the aeroplane, but the following were provided in the event of accidents and emergencies during the final erection and tests:—

One complete undercarriage.
One radiator.
One engine.
One tail skid.
One main plane (unassembled).
One set of R.A.F. bracing wires.
One complete set of oil, petrol and water piping.
One set of fabric covers for planes.
Two wind-driven rotary petrol pumps.
Four small propellers for same.
One pair of tail plane skids.
Assorted bolts, nuts, etc.

Handling and Housing.—Owing to the absence of any housing arrangements at Newfoundland, one Hervieu hangar, 80 feet by 70 feet, was forwarded from England to the aerodrome, but owing to the lateness of its arrival, insufficient time remained for its erection before the flight, and it was afterwards sold. It was therefore decided to erect the aeroplane in the open, using canvas sheets supported by scaffold poles as a wind protector.

The following equipment was provided for the handling of the machine:—

Two sets of blocks, falls, slings, ropes, etc.
Two rotary petrol pumps for filling machine tanks.
One " Buick " car, seven-seater, obtained in Newfoundland.
Chocks and trestles were made on the spot from packing case material.
Fuel.—1,948 gallons of petrol and benzole. Eighty gallons of Castrol lubricating oil.
Miscellaneous.—Blow lamps, tape, string, bench vices, dope, solder, paint, varnish, etc.

The equipment of the expedition on this side was not difficult as all the materials were to hand, nor had we any difficulty in arranging the crew. The late Sir John Alcock, shortly after the Armistice, had come to us as chief test pilot following demobilisation. There was no question of doubt in our minds as to his suitability, both as a pilot and man, for undertaking this flight. Great physical strength, together with skill as a pilot and a steady head, were necessary to undergo what we knew was bound to be a great ordeal. The question of navigator was far more difficult. Sir Arthur Brown came to see us, and suggested that he would like to undertake this flight. We were very much impressed by him, and after weighing up everything, came to the conclusion

that he was in every way suitable to undertake the navigation. In this we were much influenced by Sir John Alcock's personal representations to be allowed to have Brown with him.

Our real difficulties began when it came to shipping the machine to Newfoundland. To be brief, our party was split up into about five lots, and I seem to remember that five or seven ships contained pieces of our expedition.

The story of the flight itself is too well known to need any details from me. The Press were given the fullest information on the subject, but our great regret was the unfortunate accident on landing in the bog at Galway, the machine being damaged and unable to continue the flight back to Brooklands. Also, owing to the machine sinking rapidly into the bog, certain damage was sustained, particularly to the petrol system, and we were never able to measure actually the amount of petrol remaining in the tanks on the completion of the flight, though Sir John Alcock told me he thought there must have been enough for at least another 800 miles, but this, of course, is only surmise. Also many of the instruments were taken from the machine and we were, therefore, unable to examine and report on them.

So far as the main structure was concerned the planes, etc., were in excellent condition and the engines had stood up to their test in a most remarkable manner. It should be remembered that during the flight the engines were run at between 1,600 and 1,700 revolutions per minute, except for the first ten minutes or quarter of an hour, when they had to be opened out to get the machine off the ground and attain the necessary height.

The lessons learned from this flight were, in my opinion, chiefly of a political nature. It cannot be contended that an aeroplane, or even a flying boat of this capacity, flying over such long stretches of sea is a practical commercial proposition, but from the designer's point of view we were entirely satisfied as to the construction, suitability of the petrol system, and the reliability of the power units.

I should like to have had an opportunity of having Sir John Alcock and Sir Arthur Brown medically examined immediately after this flight as it might have been an interesting study. However, the congratulations of their friends and the excitement of the moment made this impossible.

This flight, coming as it did between the wonderful performance of the N.C.4, piloted by Lieutenant-Commander Read, of the United States Navy, and the historic voyage of the R.34, gave a prominence and stimulation to the cause of aviation which I do not think could have been effected by any other means. Each enterprise was undertaken on rather different lines. For instance, the N.C.4 was a thoroughly organised expedition with complete equipment for maintenance of machines, the route laid out giving halting places for overhaul, etc.

The lessons learned from that flight were of inestimable value as showing how, with organisation and good maintenance, long distance flights could be made. Some people were rather inclined to belittle the performance, but I think this was probably due to the excitement of the moment and the lack of appreciation of the objects of the flight.

We heard that they had to change their engines and therefore the flight was not so good as that of the "Vimy." I do not consider that this is a fair criticism, because it is a generally accepted principle that the success of every aerial transport enterprise will be attained by efficient ground organisation and general maintenance of the machines, the actual flying from point to point being a mechanical effort on the part of the pilot of the machine.

The flight of the R.34 was a carefully conceived and prepared enterprise to test out the construction of the rigid airship, together with an examination of methods of navigation, communications, etc., and from this point of view the scientific data collected were, as we have all heard, of incalculable value.

Thirdly, there was our non-stop Newfoundland to England flight, which I am quite prepared to state frankly was a " stunt " performance.

Immediately these flights had been accomplished the whole world woke up to the fact that aviation is a real and living thing, and there seemed to be a general desire to push ahead somehow. Thus, we found competitions being formulated in many different parts of the world and a general trend of propaganda towards the establishment of aerial lines between various important points. This contributed in no small degree to the signature of the Air Convention in Paris and the consequent opening of civil aviation traffic.

When we had had time to let the results of these three flights soak in, it became evident to us that something further was required, and we began to consider a trans-continental flight with a view of still further assisting aviation and testing our machine.

At this time Mr. Hughes, Prime Minister of Australia, announced the generous gift of £10,000 to the first Australian pilot to fly home to Australia. I may say that immediately following that announcement it seemed to me that half of Australia came to visit us and asked to be allowed to fly home. It was really a heart-breaking job to have to turn away so many gallant and distinguished pilots and to feel that we could only put up one machine, whereas we could have filled comfortably 20 or 30!

The organisation for this flight was rendered comparatively easy since Sir Ross Smith and Sergeants Shiers and Bennett had flown over a great deal of the route and surveyed the rest of it personally, and were therefore fully cognisant of the whole of the conditions from England to Australia. The collection of data, maps, petrol supplies, and the many other details, were of a complicated nature and had to be pushed with great despatch, for we did not wish to subject the machine to more severe conditions than could be helped and we had to arrange for the latter part of the flight to take place before the rains which occur in December down the Malay Peninsula.

This flight was a very serious proposition. Starting in winter weather from London, storms over Europe, rain and a certain amount of heat in Egypt, considerable heat through the day time in India, and then the great heat over the Equator, together with damp and rain, was putting a very severe strain upon the actual structure of the machine and engines, apart from any effect they might have upon pilots and mechanics. These conditions, however, seemed as nothing to our very gallant crew.

The machine was again a standard " Vimy " bomber which we re-purchased from the Government. The engines were specially tuned up for us by Messrs. Rolls-Royce, Ltd.

The following alterations were made to the machine:—

Elimination of armament.
Capacity of oil tanks increased from 26 galls. to 40 galls.
Alteration of loading (see Appendix AA).

The aerodromes on this route being comparatively close together, it was considered that a petrol capacity sufficient to carry the machine 1,000 miles in one flight was essential, as the information at that time with regard to the petrol supplies at some of the intermediate aerodromes was doubtful.

The following spares were carried (see Appendix A).

A noteworthy point is that Ross Smith did not elect to carry wireless equipment with him; the reasons he gave were that it would take up valuable space, though adding but little weight, and that for more than half the flight it would be useless to him as there would be no ground stations with which to communicate.

The full story of this flight has been very fully told in the Press, and I do not think there is any reason to recapitulate it here. I append, however, an extract from one of his letters which I think is of interest:—

"I attribute the fact that only one magneto, three valve springs and two contact breakers have been replaced during my journey as far as Delhi, to the excellent design and manufacture of these accessories, and to the splendid work of Shiers and Bennett. I have only had one tyre puncture, caused by a prickle on the aerodrome, and the remaining three tyres were in the same condition as when we left Hounslow."

Apart from the appalling weather, the air route from England to Calcutta appeared to be, on the whole, pretty satisfactory. The Royal Air Force at every port of call were of the very greatest assistance, and Captain Ross Smith in his private letters and despatches repeatedly refers to their unfailing courtesy and eagerness to help.

Remarkable on this flight was the navigation. In no single instance did Sir Keith Smith appear to have got out of his bearings, and it would be interesting to draw your attention to the fact that the following instruments were carried:—

Smith Revolution Indicators.
Smith Airspeed Indicators.
Smith Altimeters.
Cambridge Radiator Thermometers.
Huson Compasses, Type 253.

Sir Ross Smith repeatedly refers in his letters to his brother's (Sir Keith Mackenzie Smith) navigation, especially with reference to the crossing of the Mediterranean in thick fog. He says: "We passed two ships in the Mediterranean which cheered us up a lot. My brother again did some fine navigation and we hit Sollum exactly."

After leaving Calcutta the flight became one of very considerable danger owing to the fact that there were no intermediate landing grounds of any sort or description, and it is quite obvious, of course, that this part of the flight up to Port Darwin is more suitable for flying boats.

This section of the route, as a consequence of General Borton's and Captain Ross Smith's reconnaissance, had been prepared as far as was humanly possible, but this, of course, did not get over the fact that intermediate landing grounds were non-existent, as it was impossible to get these prepared in time. In the Dutch East Indies conditions were very similar. They have there a small nucleus of an Air Force with one or two aerodromes, and we owe a debt of gratitude to the Governor of the Dutch East Indies and his officers for having made possible the flight over their section of the route. They prepared extra landing grounds and placed parties of workmen at the disposal of our crew, at what I happen to know was considerable trouble and cost. This is a fact that I am very anxious to make public. The work was, of course, done in a great hurry and not in any way complete, and for this reason the difficulties of flying over this section were increased. The season was rainy at that time, and the machine was subjected to considerable strain owing to the boggy nature of the ground. I think the story of the start from Sourabaya, halfway between Kalidjatti and Bima, exactly describes the amazing resource and fortitude of this crew. The aerodrome had a hard, thin surface, the ground beneath being soft to a considerable depth. The machine repeatedly sank in beyond the axles and the difficulties of getting off such an aerodrome were appalling. Twice the machine was bogged in endeavouring to taxi to a suitable position, and seven hours were spent in moving it 400 yards, a successful ascent being eventually made from a specially constructed road of laced mats 350 yards in length and 20 yards in width, bamboo mats flying in all directions owing to the slip-stream of the propellers.

This machine has now completed something over 15,000 miles; the only defect of any note which occurred was the breaking of a connecting rod. This was obviously due to one of the propellers having been injured during the earlier flights and setting up vibration, and it is hardly fair to draw any lesson from

this, because it is not a thing that would have happened on any properly organised air route.

Sir Ross Smith in his letters has given a few tips which I think may be useful:—

"Utmost importance to keep oil clean and watch mixture carefully, owing to needle valve seatings wearing. Completely change oil every 20 hours, cruise under 1,700 revolutions, strain thoroughly petrol, oil and water, clean all strainers and check clearances often. Have water pump gland well packed with grease and screw it only thumb tight. Strip pumps every 30 hours, spray valves and guides with kerosene vapour after flight to prevent sticking. Watch holding-down bolts for engines very carefully owing to shrinkage of engine bearers. Use brass bound propellers as ours and always cover from sun. Turn radiator overflow pipes into wind, keep tyres fairly soft, watch oil ways to rocker arms."

He further recommends that boards should be carried for locking the ailerons when the machine is pegged down for the night, and that all control pulleys should be replaced with sprockets, and the cable at that position superseded by chains. He also suggests that an additional four magnetos, 24 contact breakers, two sets of needle valves, seatings for float chambers, a small vulcaniser for tyre repairs, and one of the most important things, a strong lifting jack should also be carried, as he broke four during this flight.

Assuming that fortune favoured Sir Ross Smith in his flight in that the machine and engines never failed him, particularly when using the bad aerodromes, what lessons are to be learned from the flight?

Possibly it may be said that in view of the general stagnation in aerial traffic this flight was of no value, to which the obvious reply is, was not a similar criticism made by contemporaries on people like Christopher Columbus?

The flight was not a sporting event only—it was a definite mark of progress. It proved that the linking up of far distant sections of our Empire with the Home Country is possible through the medium of the air at a speed which cannot be approached by any other known means of transport.

This flight was accomplished with the most elementary organisation, hasty preparation, and making use of apparatus, the design of which we knew to be in the transitional stage only. Looking at the matter from this point of view, one cannot but feel great faith in our art of aviation.

I propose now to turn to the African flights undertaken by our machines.

The "Times" aeroplane was a machine we call the "Vickers-Vimy-Commercial," which is in many respects identical with the war machine except that we have entirely re-designed the fuselage, full descriptions of which have appeared in the technical Press (see Appendix B). This machine was chartered by "The Times" to carry their representative, Dr. Chalmers Mitchell, and was undertaken purely from the scientific and commercial points of view. The flight has come in for a considerable amount of criticism, but I think has been, if anything, more conducive to our knowledge of flying conditions than either of our former efforts.

I am afraid we have very little information, except in telegraphic form and what has appeared in the Press, of actual technicalities from our pilots, Captains Cockerell and Broome, but I do not think they will have very much more to say than has already appeared. The actual details of the flight are very widely known now and appear to be a succession of engine failures coupled with the most amazing courage and endurance on the part of the pilots, passenger and crew.

(For list of spares and equipment carried, see Appendix C).

In the first place it was indicated that engines have not yet been designed

which can stand up against a continuous journey across the whole length of the continent of Africa.

The reply one would make to this is that certainly engine failures were frequent, but is it not a fact that when trouble developed it was impossible, owing to the elementary state of this air route, to obtain spare parts at each halting place and so keep the machine in commission? It is usual in all kinds of transport to have depots where repairs can be effected, but in this instance it is obvious that these facilities could not exist until the air route was definitely open for traffic, as the necessary expense would have been unwarranted from the point of view of the Air Ministry, who could not know what machines would attempt this pioneer flight. From our point of view there was not time to put supplies of aeroplane and engine parts all along the route awaiting the machine, as the flight was undertaken at a time when speed was essential in order to race the weather. Equally, the apparatus was not specially designed for flying through these climates, but we were merely trying out a type from which we could draw conclusions and make special modifications, if necessary, in case of a mail service being inaugurated in South Africa.

A further difficulty which arose was, in addition to the heat, the high altitude of some of the aerodromes and the surrounding country being unsuitable for a forced landing in case of necessity. It was owing to this that Colonel van Ryneveld (for particulars of machine and spares, see Appendix D) and Captain Cockerell both crashed their machines, fortunately without injury to themselves and their crews. Had the aerodromes been sufficiently large, it is doubtful if these accidents would have occurred.

I have tried up to now to give in as condensed a form as possible the various occurrences in connection with our long flights. A glance at the map will show the extent of territory which has now been covered through long distance pioneer flights, and before going any further I want to emphasise again that these flights were of necessity sporting in their nature, although the objects to be attained appeared to us to warrant their being undertaken in this manner in order to give impetus to commercial aviation and to make a beginning of the opening of the "All-Red" Air Routes when, and as, prepared by the Department of Civil Aviation.

Vast distances have now been successfully covered and it remains to be seen if the results obtained can be cemented by the inauguration of regular freight-carrying services over them for the benefit of our Colonial possessions.

Again, a glance at the map will show what countries have been passed over, and in this connection I wish to draw your attention again to the map of Africa. Taking Cairo as a start, one finds that by making two daily flights of three hours duration on a modern machine, very rapid communication is opened up between Cairo and Cape Town. It may not be necessary, perhaps, to get to Cape Town direct; it might quite fill the bill to go as far as Broken Hill or Livingstone at the commencement. From the communication point of view the most interesting part of this route is from Cairo to Tabora, as this definitely links up Abyssinia, Uganda, British East Africa, and the former German East Africa with London in a few days, whereas it now takes weeks by rail and sea to get direct communication for human beings and mails.

Frankly speaking, at the present time there is no doubt at all that the business man of to-day is sceptical on the question of successfully running aircraft. It is not only the question of cost, but there would appear to be also a feeling of uncertainty as to the goods conveyed by this means reaching their destination regularly and up to time. A great deal of what one has read and heard has been in connection with crashes. During the war one heard "so many hostile aircraft attacked so many of our machines, so many machines missing"—and so on and so forth. Captain Cockerell recently stated, "The art of flying is to know how to crash." Subsequent to the war the meteorological information is that

"the weather is unsuitable for flying." I may say here, in parenthesis, that although unsuitable for flying a great many machines go up and accomplish their missions on a very great many of these days, thanks to the gallantry, skill and faith in their machines of the pilots.

I propose, however, to look into the question rather from the financial side and to give a few figures as a basis of discussion in the hope that this may lead the public to appreciate that although the costs of operation are undoubtedly high, the expenditure will be well worth it from the commercial point of view. I do not, of course, take into consideration such points as the necessity for our supremacy in the air, and a healthy flow of machines plying between various points in the globe being an additional safeguard against enemy action at any time, should such an unfortunate eventuality occur. I believe a great many of the doubts arise because there is but little reliable evidence to show what it really costs to run an aerial service. Figures have been put up from time to time showing that aerial transit costs anything from 5s. to £50 per ton mile.

Generally speaking, in estimating running costs of any service for twelve months the calculations are based on a pessimistic figure for depreciation and a high cost for maintenance. The amount of fuel to be used is easily calculated, but one of our greatest difficulties is insurance. This is not a general market yet, and in view of the comparatively small amount of business done the prices are bound to be high, and if aircraft are operating they must remain so, for in spite of the remarkably few accidents which do occur they bear an unreasonable proportion to the business as a whole.

I give in Appendix F an estimate for flying between two points about 300 miles apart, assuming that a twin-engined machine of the "Vimy" type fitted with "Eagle" Mark VIII. Rolls-Royce engines is utilised, and that one ton of goods are carried each way per diem. As a matter of fact this particular machine with full load is capable of carrying over 3,000lbs., but I think for purposes of making out an estimate it is advisable to make an allowance of about 75 per cent. of our full capacity, which gives us the one ton load.

The number of machines required for this service would be six, viz. :—

Two flying.
Two standing by in case of necessity.
Two in the workshops undergoing overhaul.

The average mileage per hour is reckoned at 80, which gives a due allowance for head winds, etc. The approximate total flying hours per diem is $7\frac{1}{2}$; and allowing 5 per cent. extra for running engines and testing, we reckon that for a year of 300 days the engines would be turning for 2,360 hours.

We have further assumed that we will be flying over one of the Imperial routes, paying standard fees for housing and landing in accordance with the Navigation Act. The total capital we reckon at approximately £125,300, which includes six "Vimys" complete with engines, $33\frac{1}{3}$ per cent. engines spare, 20 per cent. of the value of machines and engines in spare parts, plant and equipment for terminal stations, suitable road transport, wireless equipment, advertising, and making an allowance of approximately £30,000 actually reserved in cash for working capital.

Taking a small view of aerial transport, a figure of about 1s. 6d. per lb. for transport over 300 miles in an aeroplane does not appear to be excessive, when one considers the large amount of perishable material there is requiring rapid transit between important points in various parts of the world. In view of the remarks I made earlier about insurance, it would appear that for a start at any rate the normal charge of 2s. 6d. per lb. which is being asked by most operating companies appears to be absolutely fair and justified; in fact I go so far as to say that this may be on the low side. However, with an increase in business a

profit should eventually be made, provided the public is educated to make use of flying machines for transport purposes, thus ensuring the machines flying daily with a full load. While speaking in this connection one cannot avoid making reference to the difficult state in which the industry finds itself to-day. The constructor is at present faced with a peculiar problem. It is realised that the development of aircraft is commercially necessary and should be hurried forward as fast as possible, but the support which is being received at the moment makes this a very difficult problem from the financial point of view. The aircraft constructor has to manufacture his own machines, which he sells to himself to operate without any support or guaranteed load, and the consequence is that the whole of his reserves of cash are being rapidly expended at a time when hard cash is essential. It appears to me that a solution might be found through a greater co-ordination between various Government departments, so that the design, research, and manufacturing sides could be separated definitely from the operating side. This might conceivably be done through the Post Office, and possibly the Ministry of Transport, making full use of aircraft and giving guaranteed loads for all transit work which has to be done at great speed. I include in this definitely mails, for there is no doubt about it these must be carried by air, particularly between this country and the Continent. The adjustment of accounts could presumably be arranged between the various departments concerned; this would to a great measure help to free the Air Ministry to devote more attention, and more important still, money, towards research; thus manufacturers would find themselves freed of their present dual anxieties, their design and research going forward strongly and healthily, and at the same time a transport industry growing up outside their works. A further point, I think, which has not yet been discussed in detail, and which I hope to hear more about in the near future, is the formation and development of a Territorial Air Force which might very usefully be inaugurated in conjunction with the mail and transport services I outlined above. I consider that R.A.F. branches of the O.T.C. should be formed at the principal Universities, and thus ensure a supply of the best personnel for training up into first class pilots. Each line over which it is proposed to work might have appended to it one or more flights engaged on commercial work of this kind, which in times of necessity, such as general mobilisation or other national necessity, might be expanded into service squadrons.

To conclude my remarks, which I am afraid have taken a very long time, I hope that the glances we have had at the map to-day, the figures which I have put up, and which I am convinced are in no way optimistic, also the suggestions for discussion of a solution of our transport and manufacturing problems, may be of some use as a basis of discussion.

APPENDIX A.A.

Standard Loading.	lbs.
Weight of machine empty with water	6,890
Weight of petrol	3,680
Weight of oil (26 galls.) ...	260
Weight of crew (three men) ...	540
Weight of military load ...	1,130
Total weight ...	12,500

Australian Flight Loading.	lbs.
Weight of machine empty with water, minus armament, plus 10 gallons extra water ...	6,800
Weight of petrol	3,680
Weight of oil (40 galls.) ...	400
Weight of crew (four men) ...	720
Weight of spares and sundries	800
Total weight ...	12,400

APPENDIX A.

(*a*) Machine Spares.

1 spare wheel complete.
1 inner tube.
6 bent plugs for tyres.
6 pairs of locknuts.
1 axle.
1 tail skid.
1 tail skid shoe.
1 tail skid box.
1 tyre repair outfit.
Spare control cables (various).
Piano wire 10g., 20 feet.
9 yards fabric.
Tape, cotton and needles.
Dope and brush.
Bolts, nuts, split pins (various).
Glue and brush.
Graphite.
Asbestos packing.
Panel pins.
1 roll rubber insulation tape.
30 feet ½in. elastic.
50 yards rope.
3 feet 2in. rubber hose.
2 rolls ¾in. adhesive tape.
20 feet 5 m.m. cable.
20 feet 8 m.m. cable.
1¼lbs. brass wire 12g.
1 ball string.
Turnbuckles (various).

(*b*) Engine Spares.

48 K.L.G. sparking plugs.
48 Lodge sparking plugs.
48 spring terminal clips.
42 inner and outer valve springs.
2 pairs carburettors (front and rear).
2 boxes Watford magneto spares.
20 nuts (gearbox to crankcase).
24 screws (valve rocker adjustment).
24 nuts (camshaft casing).
6 nuts (tachometer drive).
4 nuts (priming nozzle).
1 nut (water pump gland).
2 rotors (water pump).
24 nuts (valves).
16 nuts (engine feet).
48 nuts (inlet pipe).
25 nuts, 2.B.A. plain.
50 nuts, 2.B.A.
50 nuts, 5.B.A.
50 nuts, 5/16.
48 nuts (exhaust pipe).
20 nuts (2.B.A. castellated).
8 nuts (magneto eyebolts).
12 nuts (gudgeon pin locking plates).
8 nuts (airscrew bolts).
4 nuts (wheel case).
8 nuts (thrust housing).
4 nuts (magneto drums).
50 nuts, ¼in.
60 springs.
24 induction washers.
6 rocker arms with collars and pins (3R, 3L).
3 inlet valves complete.
3 exhaust valves complete.
6 compensator needle valves.
6 needle valves complete.
6 floats.
6 contact breakers (3R, 3L).
12 oil scraper rings.
12 compression piston rings.
2 sets platinum points.
1 gross assorted shims.

(*c*) Engine Installation Spares (Australia Flight).

1 centrifugal petrol pump.
1 windmill for petrol pump.
Pipe clips (various).
1 set water connections.
Copper tube (assorted).
Petrol resisting rubber tube ½in. i/d. 6ft.
Rubber connections (assorted).

(*d*) Outfit of Tools (Australia Flight).

2 torches.
2 batteries.
2 spare bulbs.
1 large jack.
2 petrol funnels.
1 oil funnel.
Chamois leather.
1 blow lamp with flux, iron, solder and paraffin.
1 pair long nose pliers.
1 pair quick grip pliers.
1 spanner, 9in.
1 screw driver, 6in.
1 screw driver, 4in.
1 pair 6in. pliers.
1 pair 7in. pliers.
1 pair 8in. snips.
1 King Dick spanner, 9in.
1 Belling wrench, 6in.
1 hacksaw with six blades.
1 hand brace.
1 hand vice.
1 half round file, 6in.
1 rough file, 6in.
1 smooth file, 6in.
1 round file, 4in.
1 Swiss file, 6in.
2 flat files, 4in.
1 flat file, 6in.
1 Swiss file, 4in.
Drills (various) 1/32in. to 3/16in.
2 pliers, 6in.
2 round head hammers, ½lb.
2 reamers, 1/16in.
2 lbs. rags.
Canvas bags.

APPENDIX B.

The "commercial" fuselage, or cabin, is spacious and comfortable, and particularly suitable for such a flight, having a floor area of 53 square feet, and a volumetric capacity of 300 cubic feet. Although normally fitted with ten chairs, only three chairs were fitted for this flight; one for each mechanic and a large comfortable upholstered armchair fitted with a writing desk was installed for Dr. Chalmers Mitchell.

Two extra petrol tanks were placed in the cabin, increasing the petrol endurance of this machine from five hours to approximately 11 hours. The construction of the cabin is interesting. It is built up of elliptical rings of box section, composed of ash flanges steamed to the correct shape, with webs of spruce glued and screwed to the flanges. These are attached to longerons and stringers, the whole being wrapped round with plywood. This construction is exceedingly strong and eliminates cross-bracing wires from the cabin.

The maximum speed of the machine near the ground with full load is approximately 109 miles per hour, the cruising speed 90 miles per hour, and the dimensions are identical with those of the "Vimy" bomber. The pilot and second pilot, or navigator, sit side by side in the nose of the machine, dual control is fitted, and all switches, petrol cocks, etc., can be operated by either pilot.

APPENDIX C.

(*a*) Machine Spares.

1 spare wheel complete.
1 inner tube.
4 bent plugs.
4 pairs locknuts.
1 skid shoe.
72 yards 2in. tape.
9 yards fabric.
Needles and cotton.
1 gallon of dope and brush.
½ lb. glue and brush.
1 axle.
Assorted nuts, bolts and split pins.
¼ lb. asbestos packing string with graphite.
1 elevator lever.
1 aileron lever.
200 feet (15 cwts.) cable.
44 feet (10 cwts.) cable.
Various turnbuckles and thimbles.
½ set left wire locking plates.
1 lb. tin of grease.
1 roll ½in. rubber tape.
1 roll ¾in. rubber tape.
18 inches 2in. rubber hose.
30 feet ½in. elastic.
20 feet 5 m.m. cable.
20 feet 8 m.m. cable.
5 yards 2in. rope.
1 bucket.
1 ball string.

(*b*) Engine Spares.

48 K.L.G. sparking plugs.
20 spring terminal clips.
30 inner and outer valve springs.
144 assorted shims.
2 contact breakers (1 R.H., 1 L.H.).
6 carburettor floats.
2 needle valves complete.
6 compensator needle valves.
3 inlet valves complete with springs and guides.
3 exhaust valves complete with springs and guides.
3 each R.H. and L.H. rocker arms complete with collars and pins.
24 induction washers.
2 rotors.
1 set of feelers.
2 sets platinum points.
2 boxes of Watford magneto spares.

(*c*) Engine Installation Spares.

1 centrifugal petrol pump.
1 windmill for petrol pump.
1 ball race.
2 lbs. 24g. copper.
Rubber connection (assorted).
50 pipe clips (various).

(*d*) Outfit of Tools.

2 lbs. rags.
1 blow lamp with flux, iron, solder and paraffin.
1 hacksaw and 18 blades.
1 drill brace.
Drills (various dias. 1/32in. to 13/64in. dia.).
1 pair snips, 8in.
1 hand vice, 4in.
12 assorted files.
3 handles.
1¼lbs. hard brass wire, 12g.
¾lb. H.T. wire, 12g.
2 taper reamers 1/16in. dia.
¼lb. emery cloth (assorted).
1 adjusting spanner, 4in.
1 adjusting spanner, 6in.
1 pair pliers, 6in.
1 hammer, ½lb.
2 screwdrivers, 4in.
1 screwdriver, 6in.
2 billy cans.
1 lb. tin of grease.
1 special tyre and tommy bar lever.
1 petrol funnel.
1 water funnel.
1 oil funnel.
1 large Patchquick outfit.
3 large chamois leathers.
1 small chamois leather.
1 handsaw.
1 tyre pump.
2 tyre levers.
1 petrol syringe.
1 large jack.
2 torches.
2 batteries.
2 spare bulbs.

(*e*) General Equipment.

Fortnum and Mason box.
Camera, tripod and spares.
Kinematograph film.
4 sleeping outfits.
6 helmets.
2 rifles.
Rockets.
Mosquito nets.
4 canvas water bottles
12 boxes cartridges.

APPENDIX D.

(*a*) Machine Spares.

1 spare wheel complete.
1 inner tube.
4 bent plugs.
1 skid shoe.
4 pairs locknuts.
9 yards fabric.
Dope and brush.
Glue and brush.
1 axle.
Assorted nuts, bolts and split pins.
Asbestos packing.
Graphite.
1 elevator lever.
1 aileron lever.
200 feet 15 cwt. cable.
44 feet 10 cwt. cable.
Turnbuckles (various).
Thimbles (various).
Lift wires (various).
1 double pulley.
3 single pulleys.
Machine controls (various spares).
Lift wire locking plates ($\frac{1}{2}$ set).
30 feet $\frac{1}{2}$in. elastic.
20 feet 5 m.m. cable.
20 feet 8 m.m. cable.
3 feet 2 m.m. rubber hose.
1 roll $\frac{1}{2}$in. rubber tape.
1 roll $\frac{3}{4}$in. rubber tape.
1 ball string.
72 yards 2in. tape.
Needles and cotton.
1 Verey pistol.
Signal flags.
1 rifle.
4 Colt revolvers.

(*b*) Engine Spares.

48 K.L.G. sparking plugs.
20 spring terminal clips.
30 inner and outer valve springs.
144 assorted shims.
2 contact breakers.
6 carburettor floats.
2 needle valves complete.
6 compensator needle valves.
3 inlet valves complete with springs and guides.
3 exhaust valves complete with springs and guides.
6 rocker arms complete with collars and pins (3 R., 3 L.).
24 induction washers.
2 rotors.
1 set of feelers.
2 sets platinum points.
2 boxes Watford magneto spares.

(*c*) Engine Installation Spares.

1 centrifugal petrol pump.
1 windmill for petrol pump.
50 pipe clips (various).
Rubber connections (assorted).
2 lbs. copper, 24g.

(*d*) Outfit of Tools.

2 lbs. rags.
1 blow lamp with flux, iron, solder and paraffin.
1 hacksaw and 18 blades.
1 drill brace.
Drills (various dias. 1/32in. to 13/64in.).
1 pair snips, 8in.
1 hand vice, 4in.
2 wood files, 4in.
2 flat Swiss files, 4in.
1 flat Swiss file, 6in.
1 round file, 6in.
1 flat rough file, 6in.
1 flat smooth file, 6in.
1 half-round rough file, 6in.
2 taper reamers, 1/16in.
1 bucket.
Emery cloth (assorted).
1 round rough file, 4in.
2 flat files, 4in.
1 adjusting spanner, 4in.
1 adjusting spanner, 6in.
1 pair pliers, 6in.
1 hammer and shaft, $\frac{1}{2}$lb.
2 screwdrivers, 4in.
1 screwdriver, 6in.
2 billy cans.
Richford grinding paste.
Scissors.

60 feet steel tape.
1 lb. tin of grease.
1 special tyre lever.
1 petrol funnel.
1 water funnel.
1 oil funnel.
1 tyre pump.
1 handsaw.
1 petrol syringe.
3 large Patchquick outfits.
2 torches.
2 batteries.
2 spare bulbs.
1 large jack.
3 large chamois leathers.
1 small chamois leather.
1 lb. vaseline.

APPENDIX E.

CAIRO TO CAPE TOWN FLIGHT.

Instruments used in "The Times" Machine and "Silver Queen."

Smith Revolution Indicator.
Smith Airspeed Indicator (m.p.h.).
Smith Airspeed Indicator (knots).
Smith Altimeters.
Cambridge Radiator Thermometers.
Oil Thermometers.
Smith Time of Trip Clock.
Smith 8-day Watch.
Huson Compass, type 253.

APPENDIX F.

ESTIMATED RUNNING EXPENSES AND UPKEEP.

	£	£
1. **Fuel.**		
Petrol, 35 galls. per hour for 2,360 hours for all machines at 4s. per gallon	16,520	
Oil, 2 galls. per hour for 2,360 hours for all machines at 10s. per gallon	2,360	
		18,880
2. **Staff**		8,820
3. **Repairs, Renewals and Upkeep.**		
Spares, Plant and Equipment Transport		13,600
4. **Depreciation.**		
At 400 hours, including Equipment and Transport		38,100
5. **Insurance**		11,500
6. **Sundry Expenses**		3,000
Total		£93,900

SUMMARY OF COSTS (NO ALLOWANCE FOR DIVIDEND).

Approx. total service flying hours at total running cost, £93,900 ... ... = say £42 per hour.
Approx. total miles covered on service, 80 × 2,250 ... = 10s. 6d. per mile.
Weight carried per machine, 1 ton ... ... = 10s. 6d. per ton mile
= 1s. 5d. per lb. for 300 miles.

DISCUSSION.

The CHAIRMAN said that he was informed that Captain Cockerell and Captain Broome were in the room, and he would ask them to come up on the platform, which they did accordingly amid applause, and Captain Cockerell expressed their pleasure in meeting those present.

Mr. H. WHITE SMITH (Chairman of the Society of British Aircraft Constructors), who opened the discussion, congratulated Captain Acland on his excellent Lecture, and said he had unfolded a truly remarkable and romantic story. They must also congratulate him upon the excellent pictures and films he had shown and which showed so vividly what it really meant to be in flight. One was lost in admiration of the courage and skill of the pilots, which had enabled them to achieve those flights and span the world in so short a time. One was also full of admiration for the organisation which Captain Acland, with his capable assistants, had established and which had each time enabled success to be attained. Messrs. Vickers were to be congratulated upon having such a splendid machine ready to undertake those flights at the end of the war. He thought no other machine could have filled the bill quite so well as the Vickers-Vimy, which could carry the petrol to traverse those long distances, and had also sufficient speed to combat the winds and to show in the hands of efficient pilots what was possible in the way of flights over long distances. But he thought we still seemed to be some way from what might be called truly commercial flight. One was impressed, when looking at those pictures, with the fact that much was necessary in the way of ground organisation before commercial flight could be truly successful, by which he meant not only successful in carrying out the service of flights day by day, but successful financially, so as to inspire the public to put money into the undertaking.

He thought the Lecturer had omitted one figure in his estimate of cost of running services, provision in regard to aerodromes. He took it that he was relying on the Government to provide aerodromes and the etceteras in connection with them. It was a very considerable addition to the capital expenditure and to the running costs. It must be remembered that aerial transport was up against railway, ship and other means of communication, which were running on a very low cost basis, and it was only by the aeroplane giving the additional speed that they could hope to succeed. They had yet to develop the commercial aeroplanes that would run on a sufficiently low cost basis to enable them to compete with the existing means of transport. People asked why there were not aeroplane services from London to Scotland, to Dublin, and all over the country, and why the mails were not carried by air, but so far night flying had not been properly accomplished. There was not the organisation for it and it could not be regarded as reliable and safe. It was not sufficiently reliable in the daytime, much less at night, and until night flying could be carried out they could not carry the mails in this country. There was no advantage in carrying the mails rapidly if they could be got to their destination rapidly enough by the existing means. A man posted his letters in the evening, the train took them to Scotland—say 400 miles—and they were ready for the addressee first thing in the morning. It was not until the aeroplanes got on to long distances that the benefit of the speed was felt—such journeys as to the South of France, Italy and Spain, on which a day could be saved. The cost must also be materially brought down. At present the mails were carried for a few pence per pound, and not 1s. 6d. per pound, as was stated by the Lecturer. Until they were successful in developing the right types of machine for commercial aviation they could not attract the right type of capital. It was not right that the whole burden of developing commercial aviation should fall upon the aircraft constructing industry. One must look forward to

attracting capital from the railway and shipping interests and financial men, and their money could not be attracted to the industry until they saw there was money in it. One therefore saw the necessity of the Government giving all the assistance possible. The Government was, however, already rendering valuable assistance and giving an important contribution towards the running cost of services by the provision of aerodromes, wireless installations and meteorological information. On the Cairo-Karachi route, which the Advisory Committee suggested should be opened up as an experimental route, it was put forward that all that indirect assistance should be given by the Government. If that fell upon the operating companies, they would find it almost hopeless to attempt to make a financial success of the undertaking. One hoped, however, that the Government would also see their way to give direct assistance. During the next few years civil aviation would be a plant of very tender growth, and would need judicious and careful help to enable it to become a sturdy plant that could go on growing unassisted. The best thing to secure the co-operation of the travelling public was such reliability that a man could plan a certain journey by air and not be disappointed and have to hark back and travel by train. That reliability was bound to come from the development, especially of the engine, which was the heart of the machine.

The CHAIRMAN said he would call upon Colonel Alec Ogilvie and Colonel McClean, who before the recent great development in aviation, as far back as 1913, flew a considerable distance up the Nile on a Short seaplane.

Mr. ALEC OGILVIE thanked Captain Acland for his remarks about the inception of the Vimy and the assistance rendered by the Technical Department. From the point of view of those in the department it was felt early in 1917 that enough new design for actual use against the Huns was not being obtained from Vickers. We thought that Vickers were the right sort of firm to tackle the big machine problem. As a Service type for general use the big machine was obviously coming on. The experimental Vimy machines which were produced gave very good value for horse-power, in weight carried, and speed. He mentioned this matter because Captain Acland was the person in the firm who really appreciated our point of view quicker than anyone.

Although these long transcontinental flights were very nice and advertised flying, what he (Mr. Ogilvie) thought would be more valuable were flights by means of which parcels or mails could be taken by relay aeroplanes. The only real advantage over other forms of transport would have to be obtained by speed, and the real speed of an aircraft could only be demonstrated by sending it along at 100 miles an hour for twelve hours a day, and this required a system of relays. Colossal distances could be covered and letters taken from one place to another in a time which would offer a big gain over any other form of transport. It was unreasonable to expect one machine to go on all day and day after day, without changing the pilot or the engine.

He agreed with the Lecturer on the necessity of separating the constructor from the operator. This had been found necessary on all forms of transport. If the making of the machines and their operation were done by the same people it would not be fair either to the constructor, the operator, or the public.

Colonel F. K. MCCLEAN suggested that there should be a much larger use of seaplanes. They should be of enormous use, particularly over the North Sea, where they would be infinitely better than aeroplanes. For flights to Holland, they could start within 10 miles of London, say at Greenwich. The use of seaplanes over the sea was an elementary principle which he thought should be observed. Then take South Africa; a seaplane going round the coast would find plenty of good harbours and there would be no need to go to the expense of aerodromes cut out of jungles, and which were overgrown again in about six weeks. The last part of the Australian flight should also be done with a sea-

plane proper. On the Overland-Cape flights the seaplane would not be much good after reaching Africa, except for looking at the temples in Egypt, and possibly going as far as Halfa and through the Sud district. He bowed to the superior knowledge of Captain Acland, who shook his head with regard to the Sud. Early in 1914 he was told all the cuttings there were wide enough in case of a landing, and that there were stations within 200 miles of each other along the greater portion of the route. From Gondokoro to the Victoria Nyanza seaplanes could hardly be used.

Lieutenant-Colonel W. BEATTY said the main difference between the African flight and the Transatlantic and Australian flights was that given good organisation, good class personnel and a modicum of luck, the two latter flights merely became severe tests of endurance for the men and material, while in the African flight the height of the aerodromes was an additional obstacle, which tried the personnel and material the worst of the whole lot. It was the little extra which broke the camel's back. The Lecturer did not include in his list of instruments a petrol flow meter, which was invaluable on a long trip, and would be useful in commercial aircraft, as it enabled the pilot to get economical running of his engine. (The LECTURER: We did carry them, but I omitted to put them in the list.) He agreed as to the necessity of separating the manufacturer from the transport firm. The manufacturer had enough to do to meet requirements in machines without having to think out what those requirements should be. The transport firms required capital, and he did not think Captain Acland helped the provision of capital by being too conservative over his running costs. The commercial Vimy was an excellent machine, but he felt confident that if Messrs. Vickers' designers had had to design a commercial machine without being tied to using certain parts of war aircraft they would have done better. Basing running costs on a modified war machine was not the way to get money from the public. There were machines designed, and he believed in existence, which would carry goods at 5s. or 6s. a ton-mile and show a profit. That was better than the Lecturer's 10s. 6d., and he thought if Handley Page's latest invention came up to expectations, that 6s. should come down to 3s. 6d.—the present price of first class railway fare—in a couple of years. If all the war machines were scrapped and orders given for modern, up-to-date machines, both manufacturers and operators should be able to make money.

Captain VIVIAN LLOYD asked if the Lecturer could give a few more details with regard to the suggested Territorial Air Force. It was a thing which was bound to come.

The LECTURER, replying to the discussion, stated with reference to Mr. White Smith's remarks that the figures put up were got out on the basis of certain lines assuming that the Government would provide the buildings, etc., this being the direction in which it is hoped State aid will be given. On certain routes it is probable that this is more than a safe assumption. If the cost of land and buildings had to be borne by an aerial transport company it would mean a considerable increase on the capital side, but he did not consider it would have an unduly adverse effect on running costs, taking a long view and providing really handsome business was done in carrying goods. He thought it was taking up a wrong attitude when one spoke of the air competing with rail and steamer. The ideal to be attained is the attraction of a certain class of business requiring rapid transport from the rail and sea with an idea of further developing the co-ordination of existing means of transport. What they had to do was to get regularity of service, which could only be done by a most efficient ground organisation; for instance, if from any cause a flight between two points could not be undertaken on any particular day, the goods would be put through by alternative means and get to their destination in reasonable time.

On the question of relays, he had not gone into this question specifically, but

he would like to subscribe to Colonel Ogilvie's contention that this was essential. There would be on an aerial line carried by heavier-than-air craft short stages to reduce petrol load and increase capacity of goods. Also, the human element has to be considered, for it is unreasonable to expect pilots to fly more than a limited number of hours per week, otherwise they would be worn out in a very short time.

He was in agreement with Colonel McClean as to the utility of seaplanes, but disagreed with their use over the Sudd district in view of Captain Cockerell's report that he could not land a large machine on the Sudd at the present time, there being a six-knot tide running and a very narrow clear passage.

He was interested in Colonel Beatty's remarks, particularly as regards the machine he spoke of which would appreciably reduce the running costs over those of present-day machines. At the same time he felt that it might be dangerous always to wait for the next improvement without first making a start with the best material tested out and available. The results of the Handley Page experiments were being awaited with great interest, and if successful he would be most cordially congratulated by the whole industry.

Commenting on Captain Vivian Lloyd's request for further details of a Territorial Air Force, he said that the idea had been mentioned to him, but had not up to the present been discussed in public in a concrete form. Speaking generally, the present military establishment of the Army allows for a certain number of Territorial divisions; he hoped that to each division might be attached a skeleton fleet of pilots and machines to be used within these islands for giving useful training and at the same time being at the disposal of the Post Office and Ministry of Transport as suggested in the paper, this skeleton organisation being capable of rapid expansion in time of necessity. Speaking of the universities he felt that a special Royal Air Force O.T.C. section might be organised at Oxford, Cambridge, Sheffield, Manchester, and other great universities, so as to give an opportunity for the training of the magnificent material which will always be in residence at these places, and from whom we shall hope to draw very useful material for aerial work. In most instances ground is available and the scheme might be worked on somewhat similar lines to those existing at present for mounted branches of university O.T.C.'s.

The CHAIRMAN announced that on Wednesday, April 21, Air Commodore Maitland would give a lecture there before the Royal Society of Arts on "The Commercial Future of Airships," and members of the Royal Aeronautical Society were invited to attend. To turn to Captain Acland's Lecture and the flight of the N.C.4, the point was brought out that it was largely a matter of organisation, and he thought the Lecturer had stated that the flight had been rather adversely criticised on that account. Long-distance flying was very much a matter of land organisation, and the great contrast between the flight of the N.C.4 and the jump straight over was that the latter was a *tour-de-force*, while the former required more organisation, more on the lines of the flights made from this country to Australia and from Cairo to the Cape. The aerodromes used in the latter, which the Lecturer said were scarcely large enough, were intended to be about 800 yards square, but some were not cleared to that extent. One must make allowance for the fact that it was largely a matter of atmospheric density, and that an aerodrome of that size in this country would have sufficed. He had intended to speak in favour of the relay system, but the point had been well covered by other speakers. The Lecturer had made a remark about accidents which was rather depressing. He thought the figures gave a more cheerful impression. The following figures published a short time ago by the Air Ministry with regard to civil flying in the United Kingdom between May 1 and December 31 of last year:—

Pilots killed per thousand flights made	.11
Pilots injured per thousand flights made	.17

Pilots killed per thousand hours flown	.48
Pilots injured per thousand hours flown	.72
Pilots killed per thousand passengers carried	.016
Pilots injured per thousand passengers carried	.16
Passengers killed per thousand hours flown	.06
Passengers injured per thousand hours flown	.61

tended to prove that flying was not so very dangerous after all. As the Lecturer had brought out so well, these long flights were the result of co-operation and team work between the pilots, the people who made the preparations, and the firms who produced the machines. The actual share borne by that firm which Captain Acland represented and which had been so successful in regard to those three directions—right across the world—he, personally, had not sufficiently appreciated before. One little point which showed the beneficial result of combined effort was the way in which the news regarding the flights came through by means of the combined efforts of the General Post Office, the Eastern Telegraph Company, and the Air Ministry. It was sent by means of priority messages, and in some cases the news arrived in London from Central Africa three hours after it was despatched. That was the combination of a company and two Government departments. Before that stage, there was the combination of the Government departments, the industry, and the pluck and skill of the pilots who took their chance and made their effort to get across. Captain Acland had put before them most clearly the details of the preparations made by the people who stayed at home, but who were more or less responsible for the others who had risked their lives in those big flights. Although those long flights were rather in the way of special performances, they brought before the world what could be done by us as a nation and, in the cases described, what had been done by the British firm Captain Acland represented. He thought those present would join him in a hearty vote of thanks to Captain Acland for his most interesting and instructive Paper.

On the suggestion of Brig.-General Brooke-Popham, the Chairman promised that copies of the Lecture should be sent to the Ministry of Transport and the Postmaster-General.

On the motion of Colonel McCLEAN a vote of thanks was accorded the Chairman.

PROCEEDINGS.

TWELFTH MEETING, 55th SESSION.

The Twelfth Meeting of the Fifty-Fifth Session was held in the Hall of the Royal Society of Arts, London, on Wednesday, April 28th, 1920, Major-General Sir F. H. Sykes, G.B.E., K.C.B., presiding.

The CHAIRMAN said it was not necessary for him to introduce Sir Sefton Brancker, who had been well known in the aviation world from the very beginning. In 1910 he started flying during the first flights which were made in India, and since then his whole interest had been bound up with aviation, and he had helped before, during, and since the war in every possible capacity. Since the Armistice he had taken up the subject of commercial aviation, and he had obtained a great knowledge of the subject.

Sir SEFTON BRANCKER then delivered the following lecture :—

AERIAL TRANSPORT FROM A BUSINESS POINT OF VIEW.

I feel very diffident to-night in venturing to speak to you about this much-debated subject. There has been a vast amount of talk and writing on the question of Aerial Transport since the day the Armistice was signed, and the British public must be bored with it. But from the practical point of view we have still only just touched the fringe of a very vast and complicated problem.

I will try to sum up the situation in Aerial Transport to-day as I see it, and I will enumerate its weaknesses and endeavour to show how they will be overcome. Everyone, of course, particularly wants to know whether it is going to pay and, if so, how. I will give you some estimates of cost and profits, but propose to avoid details as much as possible and stick to broad principles. From much past experience of statistics, I am certain that I could prove to you that either it should pay to-morrow—or in five years time—or never, just as might suit my own interests at the moment, by a little judicious wangling of the figures involved. So I propose to avoid details, but I'll try to answer any questions that I can afterwards to elucidate further any important points.

Aerial Transport must include airships as well as aeroplanes, and, generally speaking, my remarks will apply to lighter-than-air services as well as heavier-than-air—but when I do touch details I will confine myself to heavier-than-air. Air Commodore Maitland only last week gave an excellent lecture on the commercial possibilities of the airship. When I allude to aeroplanes, I wish to include seaplanes.

Now aviation has no complete analogy and no applicable precedent in the past. I used to try to fetter military aviation to the orthodox Army organisation, but it was impossible. Old-established methods of supply, command, organisation, etc., would not fit the new arm.

It always needed special treatment by a special department who knew it and understood it. Thus the Royal Flying Corps grew up somewhat aloof from the main Army organisation, as did its sister, the Royal Naval Air Service, from the Navy, and eventually they joined hands and broke completely free under the ægis of a new and independent ministry. There are many lessons to be learnt from sea, rail and road transport, but the expert in any one of these activities who thinks that he can apply his own rules rigidly to aviation is certain to come to grief.

This same principle should also apply to the attitude of government towards aerial transport. It is a *new* trade which has yet to be created and a trade which demands a higher standard of personal efficiency in the men employed therein than any other because of the delicacy of its equipment and the inherent danger of flying; it cannot be handled by methods which apply to means of locomotion which have existed for hundreds of years.

Aerial Transport operations can be divided into three fairly distinct categories:—

1. **Regular Express Services,** carrying mails, parcels and passengers at a very high speed punctually to a fixed time-table, as a supplement to the ordinary means of transport by rail and boat. Special aircraft could be provided in such a service to run at any time to any place in addition, just as a special train is provided.

2. **Irregular Services,** carrying all commodities over tracts of undeveloped country in which roads and railways do not exist or are extremely bad.

3. **Aerial Survey,** including the survey of undeveloped country; fire patrol in large tracks of forest; correction of plans of towns; the location of whales, seals and fish and so on.

Each of these three categories requires different handling and organisation and different equipment.

The Regular Services to be of real value to the public must be very much faster than other means of communication and *must run to time*—and this can and is being done. Very fast aircraft of at least over 110 miles an hour are, therefore, essential, and flights must be carried out practically regardless of weather. Weight-carrying power must be sacrificed for speed; the personnel employed must be highly efficient; and to get all this, rates must be high. A service on these lines, properly organised in comparatively short stages, should average 100 miles an hour day and night.

The London-Paris service is a good example of this, and the promised Cairo to Karachi service must also be run on these lines, to compete with the existing services. Airships operating over the longer distances, *e.g.*, the Atlantic, can fly slower. Air Commodore Maitland estimates the speed required to be 80 miles an hour.

The **Irregular Service** does not make such high demands. Speed is of less importance, and weight-carrying power can be increased. Running to time is unnecessary, and the saving of a few hours—or indeed a couple of days—over a route which may take a month to traverse by other means is a matter of small importance. It will be possible to wait for good weather and for full loads. Such services should be invaluable in undeveloped countries, and the cost will compare quite closely to other means of transport. Examples of this can be found between Khartum and the Great Lakes and between Fort Jamieson and Blantyre and in many other places in Africa, Australia and elsewhere.

The Third Category, Aerial Survey, is rather different. It can hardly be called aerial transport proper, and, personally, I think that as this side of aviation develops, the aircraft employed will probably be owned and maintained by the organisations which they are serving and not by Aerial Transport Companies. Speed and weight-lifting power are of no importance, and flying would not take place in bad weather. Almost any air-worthy aircraft can perform these duties, and in many cases the small airship would undoubtedly be the best craft for the purpose. I shall not allude to this branch of Aerial Transport again.

The first two categories have a good deal in common and may to some extent be compared to the big mail-carrying Shipping Companies and the tramp steamers of the sea. Regular express services tend to eliminate the time factor

in any problem; irregular services the space factor, which, of course, again amounts to time.

Both have one basic problem in common, the distance over which it is economical to fly without landing and filling up with petrol. Personally, I think that if a longer stage than 300 miles with an aeroplane or seaplane is flown, petrol is being carried from point to point at exorbitant rates and is eating up useful carrying power. In uncivilised and undeveloped countries it may be necessary to fly further without filling up, but not often.

At present the aeroplane is essentially a short-distance vehicle: its advantages are its speed and its power to surmount obstacles. For long distances during which no stop is to be made the airship, with its greater lifting power, is far more suitable. If long distances are to be covered by aeroplane they must be broken into stages of 300 or 400 miles where fuel can be obtained and pilots and aircraft changed if necessary. Airships and aeroplanes are not rivals at present except for the money necessary to develop them. On the contrary, they should be close and loyal allies, whose co-operation will materially assist the development of Aerial Transport.

I have reviewed very briefly the main functions of Aerial Transport in commerce. The business man will accept the fact that *if* these functions can be performed *efficiently* and *economically* Aerial Transport is at once a business proposition and a very valuable asset to commercial development generally; but the business man has two very serious criticisms, he charges aviation firstly with being too unreliable, and secondly too expensive, and I will now try to examine these charges and see how they can be refuted and how certain admitted weaknesses can be met and eventually eliminated.

Let us take the accusation of unreliability first:—

Unreliability is the result of three factors—

1. Personal error.
2. Failure of material.
3. Weather.

Take personal error first. This can be eliminated to just as great an extent as it has been in the navigation of big ships, in the running of express trains and in the driving of motor-cars. A mistake in the air may have worse, or at all events more fatal consequences than a mistake on sea and land, and therefore the qualifications demanded from aircraft pilots must be more comprehensive and exacting than is the case in the other transport services. But plenty of suitable men can be found. The piloting on the London to Paris service is a good example; it really has been wonderful; there has only been one accident resulting in any injury to personnel in nine months of continuous flying; bad landings have been practically unknown.

Pilots must be carefully handled. A pilot flying on a regular service through any weather must be given short stages and plenty of rest. London to Paris is quite far enough for one stage in *bad* weather; any further distance puts too great a strain on the pilot and will be conducive to a desire to take refuge at intermediate landing-places instead of pushing straight through. In irregular services, where flying is not necessarily carried out regardless of weather, the pilot can be called on to do more, and also on regular services in happier climates than our own. The whole problem of the future status, responsibilities and administration of aircraft pilots and crews is a very interesting and complicated one, but of one point *I am certain: personal error on the part of the pilot can be practically eliminated altogether.*

The next source of unreliability is mechanical breakdown. The design and manufacture of both engines and aeroplanes have reached such a pitch that with proper organisation and maintenance mechanical breakdown of these individual units should never occur. Installation still leaves much to be desired. The flights

interrupted by mechanical defect on the London—Paris service total only 13 out of 490 scheduled, and practically all these were cases of failure of installation.

In fact, reliability in equipment is largely a matter of good organisation, administration and personnel.

The mechanics must be of the very best and inspired with that sense of duty which was created in the Service and which has no equal in any other branch of transport. Periodic inspection and overhauls must be most carefully carried out, and the shorter the flights within limits the easier it is to ensure that nothing can go wrong. As I will show later, profits depend on how much work can be got out of a given amount of equipment, but if aircraft are not overworked and are properly looked after failure of material should never occur.

Now I come to the one serious cause of unreliability, the weather. If it wasn't for climatic conditions Aerial Transport would be a solid certainty to-morrow and would run with greater regularity than trains or ships. It is the climatic element which gives to aviation the romantic and adventurous atmosphere which used to attach to the seafaring profession in the old days of sailing ships and unexplored oceans. The weather is at once the most interesting factor and the most dangerous enemy of Aerial Transport. We must know our enemy and all his movements to fight successfully in any form of war. The practical study of the weather and rapid weather reporting are going to form the very life-blood of the industry.

In the old days of 1910-13 wind and storms made flying impossible, and now we laugh at them. A fast powerful aeroplane will fly through almost any wind so long as it can get off the land without being blown over. Storms can be foretold, seen, waited for, or circumvented. We have flown in 60-mile-an-hour winds on the London—Paris service.

Varying climatic conditions will give trouble. We have heard of the difficulties of getting off the ground in the hot weather in India, and on the high warm plateaux of Africa. We know that in Asia and Africa there are areas in which it will be necessary to pave aerodromes to make them usable during the rainy season. We know that intense heat warps wooden spars and splits propellers.

So far as the aeroplane goes, these climatic conditions can be met in any part of the world by using specially designed or modified types of aircraft or by carrying lighter loads in certain conditions and by ground organisation.

The only form of weather that offers a really difficult problem is bad visibility, and, fortunately or unfortunately, as the case may be, bad and continuous invisibility is confined very largely to this particular quarter of the globe. Bad visibility is brought about by fog and mist, low clouds which cover the tops of hills, and heavy snow. Low clouds which give a clearance of 600ft. between the ground and their bottom surface are no serious obstacle; lower than that flying becomes unpleasant, and eventually, if the clouds come right down to the ground, it is necessary to fly through them or over them, and at once navigational difficulties arise. It is the difficulty of flying when visibility is really bad that is the primary cause of unreliability in Aerial Transport to-day. The dangers involved are two: the possibility of losing the way and the possibility of being unable to land safely.

There are, broadly, two schools of thought in aerial navigation amongst heavier-than-air pilots. The first is to navigate in the true sense of the word, that is, to study the weather reports on the route and fly whichever course and at whatever height offer the best weather conditions, trusting to compass and careful observation of the wind to find the way. The other is to adhere rigidly to a marked course on the ground well provided with emergency landing-places and never to lose sight of the earth completely, no matter how low it may be necessary to fly in order to see it.

The second method is at the moment the most popular with aeroplane pilots, but it is unprogressive and unimaginative and places the reliability of the service far too much at the mercy of the weather. It rather reminds one of the days when ships scarcely ever dared lose sight of the shore.

The reason that pilots like it is that at present communications are so bad that rapid weather reporting is impossible, and when leaving the ground they cannot know what the weather is like in front of them. They have probably heard what it was two or three hours before, but that is often useless in this changeable climate of ours, and they prefer to fly under the weather, and so know the worst and be able to stop at an emergency landing-place if it becomes impossible instead of soaring above it and trusting to finding weather at the other end possible for landing.

The first method is the right one, and is the more reliable, more comfortable and safer, given one thing—really rapid and dependable weather reporting; and this can only be obtained by a very efficient and complete wireless system.

Airships and big aeroplanes will all be provided with directional wireless in the near future, from which they can plot their exact position every quarter of an hour or so if they like. Small aeroplanes which cannot carry a navigator and have no chartroom accommodation will be provided with a pilot's telephone, by which he will be able to hear all about the weather in front of him, and in emergency will be able to ask down through the clouds over which he is flying whether the visibility below is sufficient for landing, and if not, will be able to hear where the weather is fit.

At present on the Paris service weather reports are seldom less than two hours old; some of them come from points considerably off the route; and aircraft are not fitted with wireless.

Next year I hope the Air Ministry will have arranged that the weather reports to the starting stations will be practically instantaneous, and every aircraft will be able to glean more information during its actual flight.

Since August last up to the first of April on the London to Paris service, 70 flights were prevented by weather out of 490 flights scheduled, or less than 14 per cent. The stage from London to Paris is climatically one of the most difficult in the world, and yet, personally, I believe that this number will be reduced to a much lower percentage with good wireless communication. Really bad visibility is usually very local, and if a good pilot knows that there is clear air in front of him he will push off through almost anything.

It is possible, also, that a small directional wireless apparatus will be devised which can be worked by a pilot single-handed and which will be used for discovering one's bearing from various wireless stations on the route.

Thus I claim that with proper wireless communication—and this communication is within our grasp with existing apparatus—the regularity of a service will be vastly improved. Having mastered this trouble, let us see what other difficulties we must face.

In bad weather it will often be necessary to fly through clouds as well as over them. Some clouds are quiet and comfortable and easily traversed, but some are full of bumps, especially clouds resting on the peaks of mountains, and flying through really bad bumps when there is no horizon by which to adjust one's balance is difficult. A slight involuntary turn produces a bank unknown to the pilot, which develops into a spiral, sometimes ending in the machine getting out of control until the solid earth again comes into view.

The antidotes to this are within our reach. First, aeroplanes can be made more stable than they are and can be so designed as to look after themselves in the worst of weather; secondly, a new instrument is just coming into use, called

a turn indicator, which, in conjunction with the compass, should enable a pilot to avoid or correct imperceptible banks; and, thirdly, continuous experience in cloud navigation will breed a contempt for the difficulties of flying blindfold.

Another minor trouble is that in getting off an aerodrome in fog, it is difficult to keep an aeroplane straight on the ground unless some objects by which the pilot can steer are visible. I think that this difficulty can be eliminated, however, by putting down straight strips of white cloth or laying out a chalk line along which the aeroplane can run.

Before the full advantages of Aerial Transport can be reaped, flying by night must be carried out to just as great an extent as flying by day. There was never any difficulty in doing this with airships, but three years ago flying by night in an aeroplane was looked upon as a heroic feat. Before the end of the war, however, both at home and in France, all pilots were trained to fly at night, and a large number did nothing else. Before night flying can be carried out on commercial routes, lighting must be provided. Lighthouses must be erected either on or near aerodromes, and much remains to be discovered as to the best form of aerial lighthouse. It must have a very powerful light indeed and at the same time must be so arranged as not to dazzle the pilot of landing aircraft.

In civilised countries I doubt if many guiding lights will be necessary on the air routes away from the aerodrome; the lights of towns, villages and railways should be a sufficient guide.

Lighting in fog is another problem that needs earnest attention, and a fog-penetrating light would be a great boon not only to aviation but to shipping and railways as well.

Well, I think that disposes of the weather, our greatest enemy and the only serious cause of unreliability in Aerial Transport at present.

It must be realised that I have painted the weather very black, but that very black weather exists only occasionally for a small portion of the year. In many countries flying will scarcely ever be seriously affected by the weather either by day or night, and indeed in far the greatest portion of the habitable regions of the earth it is only a comparatively short rainy season that will give any serious trouble at all. Our own difficult weather may be a blessing in disguise, for it will automatically create pilots, aircraft and instruments without equal in the world.

I hope I have made you realise that the reputed unreliability of aviation is not so serious as is usually depicted, and is but a passing phase. It can be cured, and quite quickly.

Now I come to the more sordid and serious enemy of Aerial Transport, finance. Aerial Transport is perfectly useless from a commercial point of view unless it can be made to pay. Like all other forms of transport or communication, capital must be risked by an enterprising public and a solid organisation created before it *can* pay, and I suppose in the old days it was just as difficult to prove that shipping lines and railway lines would pay as it is to prove the remunerative possibilities of Aerial Transport to-day.

Unfortunately, at this moment of financial uncertainty the men who command the money which could tide Aerial Transport over its early troubles are being more tempted by high profits in merchandising, and they also wish to keep their capital as liquid as possible. So Aerial Transport does not attract them.

I will first deal with the various items of expenditure involved and try to show how these can be reduced in the future, giving some concrete examples of actual cost in the course of my remarks. First, it *must* be realised that aviation is a trade in which it is *not possible to cut expenses;* everything must be of the best—personnel, material, administration, fuel, etc.; and it is necessary to pay highly for the best of everything. One of the dangers of competition to-day is that it may lead to unjustifiable economies, which in their turn will result in

accidents and unreliability and a general set-back in the progress of Aerial Transport.

The Government has undertaken to assist Aerial Transport enterprises by providing aerodromes, sheds, and a weather-reporting organisation at certain fixed rates, and this is of very material assistance, as it eliminates the heavy item of *capital* expenditure.

I will start by giving an estimate of the cost of the London to Paris service, the figures being based on actual experience. I cannot give you the actual figures of the present service for obvious reasons, and they would be misleading, as the service is being conducted by aircraft designed for war, and therefore uneconomical for commercial purposes.

I will assume we want to run three machines a day each way between London and Paris. For this purpose, I reckon that we must have fourteen aeroplanes to provide a sufficient reserve on the ground and to cover machines under repair. We will use on this service an " X " type single-engined aeroplane, flying at 110 miles an hour and carrying one ton of goods or eight passengers. This machine actually exists.

The capital costs involved are, roughly, as follows:—

14 aeroplanes with engines at £6,500	£91,000
Spare engines	10,000
Other spares	20,000
Transport vehicles, tools, etc., etc.	9,000
Working capital	10,000
	£140,000

Thus the capital necessary is very small as compared to the money required for other forms of transport. I understand that in railways constructed in undeveloped countries it is necessary to put in at least £4 capital to obtain £1 gross income; and that in developed countries an even higher rate of capital is required. Air Commodore Maitland, in his lectures before the Royal Society of Arts last week, gave us some very interesting figures about airships, and they did not appear at all excessive when the capital required for starting a shipping line or a railway is considered.

Heavier-than-air craft services require far less capital than lighter-than-air and can be started on a much smaller scale, as, for example, our London to Paris service. It is the running costs that are comparatively high for the load carried and that are susceptible of improvement.

These running costs can be divided into two categories—ground costs, which may be somewhat illogically described as overhead charges, and flying expenses, which are only incurred when aircraft are actually in the air. The ground costs cover:—

Aerodrome and shed accommodation.
Weather reporting.
Communications and transport.
Basic pay of pilots.
Pay of personnel.
Insurance (Perhaps).
Interest on capital.

Now I can't give you the detailed figures of the London—Paris service for these ground costs without giving away secrets, but I can say that they would total about £45,000 a year excluding insurance and interest on capital, but including a ground organisation in France, which could be considerably cut down when the service is firmly established.

The Government provide aerodromes, sheds and a weather reporting system at certain fixed rates; the pay of the personnel may be considered high, but a comparatively small number are required; generally speaking, these charges are fairly well fixed and are not capable of very much modification.

It is when we come to flying expenses that our troubles begin. These comprise:—

Fuel consumption.
Depreciation (including cost of repairs).
Pilots' flying pay.
Insurance (Probably).

Let us assume that each of our 14 aeroplanes flies 300 hours in the year. Counting the trip to Paris as 2½ hours, including test flights, etc., this represents 4,200 hours flying, or 1,680 trips. Reckoning on six trips a day, three each way, this requires 280 flying days in the year—a low estimate, but we will see what it leads us to statistically. The costs are:—

Fuel for 4,200 hours at £5 an hour	£21,000
Depreciation at 50 per cent. (including obsolescence)	45,500
Insurance at 20 per cent.	18,200
Pilots' bonus at 10/- per hour	2,100
	£86,800

I am putting most of these charges at a very high rate. This, with the £45,000 a year ground charges, gives us an expenditure of £131,800 a year without interest on capital. This sounds a lot for 14 aeroplanes, but let us now look at the other side of the question. 1,680 trips brings this down to a cost of £78 10s. a trip. £78 10s. to carry a ton at over 100 miles an hour for 230 miles is not so bad, and works out to about 8½d. a lb., or taking eight passengers, to £9 15s. a passenger. At the present rate of 2/- a lb. and £15 15s. a passenger *given a full load*, the service would be earning £224 a trip, or £376,320 a year if goods only were carried and £126 a trip, or £211,680 a year, if passengers only were carried, and somewhere between the two—say £175 the trip, or £300,000 a year, if mixed cargoes were carried, *always presupposing a full load*.

This, as you see, gives about 100 per cent. profit on your capital.

What is the snag? Just this: I have assumed that we shall carry 6,720 passengers and 840 tons of goods at these high rates in the year, and it can't be done; we shall not get the assumed full load.

Now what must we earn to "break even"? Assume 10 per cent. on our capital, and our costs go up to £145,800 a year, so we have to earn about £86 14s. a trip, let us say £87. Let us assume that we have a 35 per cent. load of passengers and a 35 per cent. load of goods throughout the year, *i.e.*, 70 per cent. of a full load, half passengers, half goods, a very low estimate for three machines a day, as 66 per cent. would fill two and leave only 4 per cent. load for the third. 70 per cent. of four passengers is 2.8. 70 per cent. of half a ton is 784lbs., and to "break even" we must get £43 10s. for each of these, or £15 15s. a passenger and 1/1½ a lb.

Thus the question reduces itself to the problem as to whether we can get more than three times this load a day each way, *i.e.*, about nine passengers and 2,500lbs. of parcels at these rates. If so, we can make a profit above and beyond the interest on the capital. Personally, I am perfectly convinced that we can do this and a great deal more once the public—and particularly the business man—has been educated to this new mode of travelling and communication and when once the reliability of the air service is established and when extensions run on to Italy, to Marseilles and to Spain. There is a point to note here; these calculations reckon on aeroplanes doing only 300 hours a year

on 280 days in the year. This is a safe estimate, but suppose by experience and good organisation it is found possible to make each machine fly 400 hours. Then at once either the takings go up very considerably or we can work with fewer machines and so less capital and carry the same loads at a higher profit or a lower rate.

I think, by this somewhat long rigmarole of figures, I have proved that an aerial service between London and Paris will pay *and pay well even with a small load factor*. If the passengers averaged 20 a day each way instead of nine and the goods three tons instead of one, large profits could be made, even after the rates had been cut down considerably.

Can we also reduce the flying expenses of such a service? The overhead charges are not high; but the flying expenses are, particularly on the items of depreciation and fuel consumption, and to some extent on insurance. Some of these, however, we can hope to reduce.

The cost of petrol is one of the great problems of the world at the moment. I can't say that I think petrol will become cheaper in the near future, but a large percentage of benzol can, and is, being used, and it should be possible to produce this considerably cheaper.

Improved design in engines and aircraft may give us the same speed and lift for a less consumption, and it is likely that the future will see power-alcohol engines, heavy-oil engines, and eventually turbines designed for work in the air; all these should do much to reduce the cost of the fuel consumed.

Now let us turn to depreciation. Depreciation depends on three factors:—

Cost of manufacture.
Obsolescence.
Durability.

At this moment it is difficult to see how *cost of manufacture* can be reduced, at all events until commercial air services develop sufficiently to create a demand for which it would be possible to build aircraft and engines on a production basis. *Obsolescence* was one of the most serious factors of wastage during the war, but will not be so in Aerial Transport once we get a satisfactory type. The cost of engines may be reduced by designing a somewhat heavier and simpler type than those in use at present, but, generally speaking, the cost of construction is likely to go up. At the moment we are using types which are either already obsolete or obsolescent, but there are a few new designs which promise to be satisfactory for commercial work, and these will not become obsolete for at least five years. Obsolescence as a factor in depreciation will therefore decrease.

Durability can undoubtedly be greatly improved. To-day flying through rain causes serious damage to both propeller and fabric. Hot climates warp and split woodwork. A bad landing jars an aeroplane right through. An engine can only run at the best for 150 to 200 hours without a complete overhaul. All these weaknesses can be eliminated. Metal propellers are nearly with us now. Complete metal construction is developing, and only needs money to become a practical proposition. Oleo-gear undercarriages will save strains in landing. Better installation will save vibration and wear and tear in the engine. In short, there should be very marked and rapid progress in durability if our private design departments can keep alive at all.

Insurance is our next large item of expenditure. I have placed this figure considerably higher than the rates which are being charged in some cases at present. The Insurance Companies in a really enterprising spirit gave low rates for a period commencing some time last year, but I fear that they will be the losers in consequence. The rates *may* go up, but in some cases, where Companies have proved themselves to be really efficiently administered and equipped, it is to be hoped that they will not. Eventually, when business becomes brisk, this

figure should easily be lowered to 10 per cent. and probably less still in selected cases.

Thus you see that two of our biggest items of flying expenditure, Depreciation and Insurance, are definitely susceptible of appreciable reduction.

Now the organisation of the London—Paris service has been based on the fact that it has to compete with boat, train and telegraph in a bad climate, and it has, therefore, been equipped with *high-speed aeroplanes*.

If this service was going to be run in an undeveloped country where high speed and regularity were not essential, an 80-mile-an-hour aeroplane with the same engine could be used. Its capital cost would be greater, say £7,500, as it would be larger, but it would carry 2½ tons instead of one. This machine exists on paper and is a practicable proposition. The running cost of such a machine, without overhead charges but with percentage on capital and full pay to the pilot, flying for 300 hours in the year, would work out to £13 16s. 8d. an hour or about 3/8 a mile. 3/8 a mile for 2½ tons at 75 miles an hour is not a bad commercial proposition, and I leave you to work out the various developments and combinations possible from that basic figure.

I have not so far mentioned the carriage of mails. It is obvious that given reliability the air is the best means of carrying letters, as the bulk and weight involved is comparatively small and the gain in time is of real importance and definite value. But, unfortunately, the existing Post Office organisation is not suited for this new development without expenditure for which authority cannot be obtained; and in addition international agreements make any alteration in the present system difficult. There are three methods of using aerial services for carrying postal communications:—

(1) Guaranteed load.
(2) Special contract.
(3) Aerograms.

The first is the simplest; the Government gives the aerial service a minimum weight of mails to carry every day at a fixed rate, and does the rest. This guarantees a certain daily income to the aerial service and is merely payment for services rendered, and it is for the Government to decide what the public pays.

The second is the system prevailing at the present. The public are free to use the aerial mail at a special increased rate, and the aerial service takes what it can get, giving the Post Office so much for each letter. The success of this system depends on advertisement and good ground organisation by the Post Office as well as on a sufficiently cheap rate. In the present contract none of these elements have existed, and the experiment has been a failure.

The third is a system by which messages can be telephoned direct to a Post Office on the aerodrome and thence transferred by air to their destination, being telephoned on arrival direct to the addressees. It claims lower cost and less congestion than the existing telegraph and telephone systems, but it involves the establishment of a very good telephonic organisation, and I think can only be treated as a special means of communication and not a normal one.

The great point of aviation from the communication point of view is that it can carry long *written* communications rapidly. I don't think that the City even now realises what use could be made out of the London to Paris service as a means of accelerating the delivery of cheques, important documents, and of saving interest, loss on exchange, etc. The dressmakers, on the other hand, have realised its advantages.

I will now try to give you an estimate of running a mail service from Karachi to Constantinople, which to my mind is a far better proposition than the Karachi—Cairo route recommended by Lord Weir's Committee last summer, at all events as soon as Armenia is sufficiently settled to permit of it.

My proposal is that the mails should be carried by air over that portion of the route which has a reliable climate and no serious international complications, and then go on by the Orient express to London through the bad climate and the area of international complications.

Another alternative would be to run by airship to Cairo and go on from thence to Karachi by heavier-than-air service, but this would not serve the other capitals of Europe so well as my proposal, and would be going out of the way. The Cairo—Karachi route is, however, of greater military importance and will be no doubt started first. I will give a rough idea of the costs involved and possibilities of a heavier-than-air service from Karachi to Cairo.

The distance to be covered is 2,700—2,800 miles. It can be divided into very convenient stages, Konia, Aleppo, Mosul, Baghdad, Busra, Bushire, Bunder Abbas, Guadir and Karachi. It could be made more direct, and therefore shorter. The longest flight necessary is 380 miles, between Bushire and Bunder Abbas. I would suggest that we start on this enterprise with a bi-weekly service, allowing an average speed of only 78 miles an hour and flying *only* by day. The distance can be covered in 35 hours, or in three days.

This involves 7,280 hours flying a year, and I reckon that in this comparatively clear climate 20 machines should do this easily. I am assuming that a comparatively small machine of low horse-power will be used.

The following is a rough estimate of the expenditure:—

Capital Expenditure.

20 aeroplanes capable of carrying 1,000lbs. or 4 passengers, at 80 miles per hour, at £4,000 ...	£80,000
Spare engines	7,000
Spare parts	40,000
Mechanical transport and communication	20,000
Tools and miscellaneous	20,000
Working capital	43,000
	£210,000

I have put spares and working capital very high, but want to be on the safe side. Annual overhead charges, including shed and housing accommodation, are rented at reasonable terms from the Government.

Pay of personnel, allowances, travelling, and all other recurring expenses on the ground, I put at £60,000.

Flying expenses can be reckoned as follows:—

Fuel at £3 an hour	£21,900
Depreciation at 50 per cent.	40,000
Insurance at 20 per cent.	16,000
	£77,900
Say, with Pilot's bonus	£80,000

So we have a total annual expenditure of £140,000 to face *at the very most*. If we can lower insurance and depreciation we can make considerable reductions.

This service would be able to carry 2,000lbs. of mails each way each week —64,000 ozs. If we charged 1/- an oz. and if we could *get a full load* the income would be £166,400 a year. But this, again, merely indicates what could be made if it was possible to get a *full load of mails* at a very low rate considering the speed.

Let us approach it from another direction. We are spending £140,000 on 7,280 hours flying, which works out to about 5/- a mile. If we could earn 6/- a mile we would make over £29,000 a year profit. 6/- a mile gives us 1/6 a mile for a passenger or 7¼d. a lb. per 100 miles. The problem is can we get it?

Personally, I think with a Government guarantee for the through mails, and special rates for letters, passengers and parcels between intermediate stopping-places, it should easily be possible, and there are certainly passengers who would pay 1/6 a mile, or £210, to get from Karachi to Constantinople in three days. I have purposely put the charges high as I do not want to be optimistic, but if we counted on each machine flying 500 hours in the year, depreciation at 33 per cent. and insurance at 10 per cent., and if we cut down our overhead charges by 15 per cent—all quite conceivable reductions—we could run this service at about 3/3 a mile and make a profit at 4/- a mile. If the demand was big enough a daily service could be run still more economically.

It may be urged that the airship is cheaper and will do the trip to India quite quick enough. Granted, but an airship cannot run so frequently and cannot call at intermediate stations. Another advantage of an aeroplane service on these lines is that it cannot completely break down. A crash or some other failure will only entail a few hours delay, whilst another aeroplane takes over the load. Eventually, certainly when Australia is linked up by air to India and probably before the demand for increased acceleration of mails will arise, high speed machines will be put into service and will *average* 100 miles an hour day and night; the Karachi—Constantinople trip will be reduced to 28 hours, and probably a daily service will be established.

Well, enough of figures. I hope I have shown you that, given a sufficient load, Aerial Transport will pay. Personally, I believe that the supply will create the demand, and that once a service is organised and proved reliable, there will be plenty of traffic. That is certainly one of the lessons we have learnt from the London to Paris service up to date.

Now I must touch on the delicate subject of subsidies.

The idea of granting a subsidy to any industry is repugnant to British ideals. I have heard a subsidy described as a narcotic, but in the case of aviation I should call it a tonic.

You may ask me why a subsidy should be given if I can prove on paper that aerial services will pay without. Well, my figures all depend on the amount of load obtained, and that is the uncertain factor. At present financiers will not put up money because no aerial service has yet had a chance of really making a profit, but if the Government granted a subsidy which would to some extent compensate for any shortage of load, then I believe financiers would step in and provide the capital required. Accounts are easily checked, and the subsidy can be stopped the moment Aerial Transport proved to be self-supporting.

A subsidy can be granted in various forms. The French allow a kilometre rate for every kilometre flown by a French aircraft with a French pilot in any part of the world and in any capacity. The rate is worked out by a very complicated formula and a sliding scale. A machine such as I assumed would be used in my London to Paris example would draw something over £60 for every trip across the Channel. This, to my mind, is unnecessarily large, and is therefore really likely to act as a narcotic.

There are three possible forms of subsidy which are most generally suggested:—

(1) A rate per mile flown.
(2) A percentage on weight carried.
(3) A guaranteed minimum load.

The first is the simplest, and a suggestion on these lines has already been put to

the Air Ministry by the S.B.A.C., based on speed and carrying capacity. It has the disadvantage that it helps efficiency and inefficiency alike, but it is the form of subsidy most likely to encourage and increase flying generally.

The second is rather on the lines of the Biblical principle that " to him that hath shall be given." It simply means that the Government pays part of the cost of the load and so enables Aerial Transport Companies to carry for the public at lower rates than could be quoted otherwise.

The third is the most limited but is the least repugnant to the subsidy-hater. The Government guarantees a minimum load of mails to a selected air service on an approved route. For example, a guaranteed ton a week at 5/- a lb. would be a godsend to the London to Paris service and would enable the Post Office to accelerate almost all ordinary correspondence.

However, it is for the Government to decide what they wish to encourage in aviation—speed, weight-carrying, horse-power, numbers—and to base any subsidy they may give on their own requirements.

Well, I think I have taxed your patience sufficiently. To sum up, I hope I have proved that Aerial Transport *will* pay, given a *sufficient load*. I plead that this load will be forthcoming on any properly selected route as soon as the air service on that route has proved itself reliable. I have endeavoured to show that an aerial service can be made reliable, even with present material and experience.

I urge that the Government should take some sort of financial share in the risks until it has been established that a paying load is available.

If the Government would do this I believe that the financiers, and eventually the public, will come forward and support new services and new enterprises wholeheartedly.

It may be asked why the Government should wish to assist Aerial Transport at all.

A great and flourishing Aerial Transport Industry will provide the country with a reserve of pilots and mechanics; it will preserve the design and manufacturing organisations which are now crumbling to ruin; it will accelerate and invigorate all forms of overseas trade; and it will link up our old Empire by closer bonds than ever existed before. Suspected by the public and neglected by the Government, British aviation to-day is at a very low ebb, but after all in 1913 it was also starved and neglected. It was in that year that we adopted the motto, " Per ardua ad astra " for the Royal Flying Corps, and within four years that Corps had indeed soared " through hardship to the stars."

Those who believe in commercial aviation, those who are supporting it, and those who depend on it, may indeed inherit that motto from their warlike elder brothers, " Per ardua ad astra."

DISCUSSION.

The CHAIRMAN (Sir Frederick Sykes), in opening the discussion, said that Sir Sefton Brancker had brought out very clearly the fact that the chief difficulty in obtaining regularity and reliability of commercial service was visibility. It was the essence of the whole problem. Without regularity commercial aviation was of little value. They were getting ahead a bit now by the adoption of direction finding and position finding wireless services. The first system was at the present time under further development. It had been used occasionally with marked success, and in a few months a reliable and serviceable article would, he thought, be produced. The position finding system, which needed its own ground stations, required much transmitting and occupation of the ether, and was thus comparatively costly, as several stations were concerned, whereas the direction finding

system required no extra ground stations and did not necessitate any transmission by wireless, as the signals made by high power commercial ground stations could be used to obtain bearings. It should be noted that this system was at the present time not so reliable or accurate as the position finding system.

The Chairman continued to give two personal experiences. During the Peace Conference he tried to fly back to London in the snow. The lecturer had mentioned that of the three factors—fog, cloud and snow—snow was the worst. He (the Chairman) and his pilot lost sight of the ground at 50 feet. They had no direction finding or other wireless instruments; they managed to climb up through the snow to 10,000 feet, at one place circling up through a complete funnel of air of about 400 feet clear of snow. Gradually they rose to 10,000 feet and steered their course by the sun for 2½ hours, seeing nothing else but rolling cloud billows and snow. They then thought that they had better come down. They did not know whether they were over the North Sea or where they were. They came down and suddenly found themselves amongst the trees and dikes between Antwerp and Bruges.

A year after that—only the other day—he was flying to Paris. There were three persons in the machine—an Airco machine fitted with wireless telephony—and they were talking back to Croydon and receiving messages from Croydon practically all the time as far as Paris. That one year meant a great increase in reliability and in the means of knowing one's position when flying.

Interesting experiments were being carried out towards the solution of the difficulties attending air navigation by night. It was hoped that as a result of these experiments powerful lighthouses would be placed at suitable points on the great airways enabling aviators to locate their position in clear weather during the hours of darkness. As the audience knew, an experimental lighthouse was already in operation at Croydon Aerodrome. Local lights, which might be compared to harbour lights, would be established on or near aerodromes for the location of their position. Experiments were also being made to equip the main aerodromes with night landing lighting apparatus of the most up-to-date kind, and with the "L" shaped lighting laid down in the International Air Convention. In addition, it was intended to equip these aerodromes with some form of flood lighting. Secondary aerodromes would be fitted with smaller apparatus, and emergency landing grounds would have wind indicators, visible at night from a moderate altitude.

The whole thing must continue to improve. The lecturer had occasionally become a little pessimistic, and though there were grounds for pessimism as they were now going through a bad time, there were also very real grounds for optimism. Things had been done during the past year which no other country in the world had done, or were doing. They all believed in aviation, and, though they were having a heavy time, they were going ahead and meant that it should be used. He knew Sir Sefton Brancker knew that and was working hard for that end.

Speaking on the subject of design, the Chairman said that much experimental work was necessary to cope with climatic conditions. That was brought out clearly on the Cairo to Cape flight. There was much experimental work to be done in regard to metal machines and metal propellers, and there was still room for improvement in the reliability of engines. Metal commercial aircraft seemed to be most desirable in certain climates. The Germans and Americans were both said to have made composition propellers, though nothing was known of these. The German Junker aeroplane, made entirely of duralumin, did away with fabric, wood and wires, but still employed a wooden propeller. The Germans had also turned their attention to the use of duralumin for hulls of flying boats and seaplane floats. All these matters which they could not touch in war-time should be dealt with vigorously in peace-time.

Wing Commander T. R. CAVE-BROWNE-CAVE said he could not imagine why he had been called upon to open the discussion on a paper of that description unless

he was required to read a corresponding discourse from the airship point of view. The lecture under discussion differed radically from the one recently delivered by Captain Acland. Sir Sefton Brancker advocated a service with an average speed of 110 miles an hour, whereas Captain Acland took 80 miles an hour flying 6½ hours a day, which averaged less than 20 miles an hour over the 24 hours. He would like the lecturer to say whether he suggested that the 110 miles an hour would be maintained during the 24 hours, and what delays were anticipated when one changed passengers over from one machine to another. If reasonable delay was allowed for at stopping places 300 miles apart, the speed of the machine would have to be enormous, and he could not help thinking the service would be extremely expensive to run. Most of the description was, he thought, based on a comparatively short flight of 300 miles, which was the type of work that should be done by aeroplanes, feeding or distributing from long main airship routes. If that were the type of work contemplated, he thought many of the difficulties referred to by the lecturer would disappear. The picture he had drawn of the part aeroplanes would play in future transport was perhaps rather optimistic. One point came out clearly. That was that if transport by aeroplane was to be made commercially sound, flying must be done by night, and the amount of experience of night flying, except for warlike purposes, was comparatively small. If one only flew by day it halved the effective speed. The airship, like the train, would travel the whole 24 hours over any distance that it was profitable to do. He imagined, however, that flying an aeroplane by night did not present very serious difficulties. It meant arranging for landing at night and flying by instruments instead of looking at the horizon. By developing the method of flying by instruments the difficulties of flying by night and also through cloud would be got over, and the strain on the pilot would be reduced. He believed the strain on the pilot of an aeroplane was much more intense than the strain on the quartermaster of a ship or a man sailing a boat. If the process of flying were reduced to steering a compass course on a stable machine the reliability of the service would be increased, because such carefully trained men would not be necessary. The lecturer suggested in regard to the Cairo to Karachi route that one should go to Cairo by airship and go on to Karachi by aeroplane, and he suggested one should go a good distance North to do it. He (Colonel Cave) could not imagine why. If one followed the route the lecturer suggested and did not fly by night it would take much longer than by airship direct. He thought 78 miles an hour was the speed the lecturer suggested. Dividing that by two for daylight flying only reduced it to 39 miles. On a route like that the advantage was with the airship. If anything went wrong with an aeroplane it had to land and another machine might be sent to take its load on, but it is very doubtful whether the relief machine could get up from unprepared ground even if the other machine had landed safely. He would sooner go from Cairo to Karachi by airship; it was safer. It would be interesting to have a set discussion between gentlemen of such widely differing schools of thought as the Author of this Paper and the one which immediately preceded it. He thought they dealt with the same problem and had arrived at widely different solutions.

Lieut.-Colonel W. D. BEATTY said the Lecturer had laid considerable stress upon the necessity for high speed, particularly in these latitudes, and said he would sacrifice weight-carrying capacity to get it. He (Colonel Beatty) considered that unsound. All design of aircraft was a question of compromise. One had to get the best compromise between the greatest useful load per horse-power and the speed which had to be maintained to secure reliability in all weathers and to compete with other forms of transport. However, although the Lecturer had emphasised the question of high speed, when he came to the type of machine for the London—Paris service he selected one which was an excellent combination of the various qualities. A machine which could cruise at 110 miles an hour, carry a ton for, I suppose, about 400 h.p., was getting well on the way to a good commercial machine. During the war there was little pressure for the

development of sea aircraft, and a large majority of people who were keen on commercial aviation had not been in touch with machines which could land on and get off the water. Aviation was a subject requiring special treatment, but the main principles which affected all business and the main facts of existence must not be forgotten. A main fact of existence was that by far the larger proportion of the world was covered by water, and by far the larger proportion of the goods of the world was water-borne, and the machine that could land on or get off the water would eventually be the commercial machine in the heavier-than-air type of aircraft. But in order to be able to use land aerodromes as well the amphibian would probably take the place, very largely, of the ordinary flying boat or aeroplane for commercial work. The Lecturer referred to stages of 250 to 300 miles. He (Colonel Beatty) thought they would get up to a 500-mile range, with perhaps intermediate stages of 250 miles in case of bad weather. If a pilot had half an hour's rest after flying 250 miles it made a remarkable apparent improvement in the weather, which encouraged him to go on. He noticed Sir Sefton Brancker and Captain Acland arrived at nearly the same conclusions in regard to cost. Working it out in ton miles at the 70 per cent. load he thought the figures the lecturer gave for the London—Paris service came out at 10/6 per mile, and Captain Acland based his figures on about the same amount. He would like to know more about the £45,000 for ground work, as he could only account for £15,000 to £20,000. He did not see how spares were accounted for, as apparently they only appeared as an item of £20,000 in the capital account. He hoped it would be a long time before petrol reached the lecturer's figure of 5/- a gallon, and with regard to obsolescence the lecturer was rather optimistic. After a year or two of improvement the best of the machines would be scrapped, therefore probably 400 hours was a right estimate for the life of a machine. The lecturer referred to a flight from the North of England over fog. It was quite authentic, and took place in February. Two Andover pupils left Ashington, in Northumberland, at 10 o'clock in the morning, flew over the fog to where they thought Andover was, then tried for Southampton, and finally flew back to the Peak in Derbyshire. They were six hours and ten minutes in the air and for nearly six hours did not see the ground.

Colonel IVAN DAVSON said the lecturer had dealt largely with the possibilities of commercial aircraft in perhaps one of the most populous parts of the world, where everybody was alive to the needs of rapidity over land and sea. He (Colonel Davson) had been recently in places where the reverse was the case. There were places where the sea was only " bridged " by schooners, places where the existing railways were slow, laborious and irregular, and also places where they did not exist at all. It was in such places as those that commercial aviation could be promoted most economically. Regularity seemed to be desired and valued generally even more than frequency of opportunities. Moreover, the lecturer's idea of an irregular service was not likely to engender confidence among people who did not understand aeronautics. There was a further matter which he touched on with diffidence. There were places where the powers that be were attracted by aviation and were tempted to commit themselves to the principle of State support, and he knew of Syndicates and firms who were much tempted to have a dash at little enterprises that looked like plums about the Empire, but in this country the idea of State support had not been encouraged. A recent State despatch rather burked the issue by suggesting that the whole question should be postponed for one year. He believed that without State support British aviation would be a long time coming into its own.

Sir ALAN ANDERSON said the real difficulty did not seem to be to decide whether airships or aeroplanes could some day be worked commercially, but what was to be done in the immediate future to get them going. He had listened with great interest to Air Commodore Maitland and Sir Sefton Brancker, but he did not believe either of them could estimate the working costs at

present. There were two factors—obsolescence and load factor—which were and which must be unknown. It might be a surprise to members to know that the load factor for first-class accommodation in Australian mail steamers before the war was under 50 per cent. The load factor of the aeroplane service would be better because fewer aeroplanes would be sent when the demand fell off. That was an advantage of using small units, but still he did not believe either Air Commodore Maitland or Sir Sefton Brancker had as yet the commercial experience of air travel on which to base estimates. Air Commodore Maitland, for instance, produced figures which agreed closely with the actual cost in ordinary mail steamers built to-day. If passengers could be carried safely in airships in about one-fifth of the time, a certain number of people would pay very many times the steamer fare for the greater speed in the air. It was impossible to say how much they would pay. A man was not at the height of his money-earning for many years of his life, and when he was at the height of it he would travel the quickest way at almost any price, and the speed would save him money. If long voyages could be made safely by aircraft no doubt aircraft could ultimately be made to pay. But how were they to be started? That was where he differed from both these gentlemen. They spoke as if aircraft were commercial to-day. He did not agree. One could not ask the public for money upon the figures at present available. Someone had to step into the breach with experiments on a commercial scale, and who was going to do it? The Government would be the greatest gainer by the commercial success of our aircraft, and the Government must help. As long as the nation delayed the commercial use of aircraft it was all outgoing and no incoming, but as soon as commerce took over air travel we should have gained a national asset. If our rulers and governors would look back to another form of transport in which we had been successful, the navigation of the ocean, they would find the same problem solved as this air problem must be solved. In the Tudor days our Merchant Venturers determined to open up new markets for our trade and to find the north-west passage to China. They did not find it, and they lost two ships the first voyage and all the ships within two years. But they discovered Russia and the trade with Russia, Persia and the East; they succeeded and set us on our feet, but they were helped by Government in three successive reigns with moral and material support, without which they would not have succeeded. And now in the same way our Government must encourage and support enterprise in the air. The chief duty of bureaucrats seemed to be to check and hamper established trade, but he hoped that the Government would make an exception.

Sir SEFTON BRANCKER, replying to the discussion, said Commander Cave's remarks rather indicated that there was tremendous rivalry between airships and aeroplanes. He asked, "Why go by aeroplane to Karachi by way of Mesopotamia?" One might ask "Why go to Edinburgh by way of Bedford?" But there were people who did want to go to Mesopotamia and to Bedford. That was a point about the aeroplane—that it did link up communication between intermediary points on any route. He suggested the alternative of running an airship to Cairo as a means of avoiding the cross-Europe travel by train. He did not support the organisation of a heavier-than-air service across Europe at present, because the climate was infernal, and every country on that line would want to run its own air service. If they did, God help the through service in present conditions. In regard to the Constantinople-Karachi route, he started with 78 miles an hour, twice a week, flying only by day. When money was available and one could afford to get sufficient high speed aircraft and the necessary instruments, both day and night flying could easily be carried out and an average of 100 miles an hour maintained. With their old "Nines" and "Sixteens" on the London-Paris service they had averaged 105 miles an hour. It would be necessary to run to time, and have another aeroplane waiting with the engine ticking round at the end of each stage. The mails would be loaded in standard boxes, and with proper organisation

the change over at each stage would be a matter of a few minutes. He started at bedrock, 2,700 miles in 35 hours, and flying only by day, but he backed himself with money to do the 100 miles an hour night and day. There was really no strain in flying in anything like good weather, and flying by night was easy in a good climate. It was better than flying by day in hot climates so long as there were good lighthouses at aerodromes. In a civilised country the villages, railways and towns gave a pilot so much indication of his position that he should be able to find his way as well by night as by day. The guiding lights to the aerodrome must be powerful but not dazzling. As regards the actual landing lights, a string of electric bulbs would do. Curiously enough, for a combination of guiding lights and landing lights he had never seen the beatings of the old petrol flares with which they started a good many years ago. He did not go into Captain Acland's lecture because he wanted to be quite free in his mind regarding details. Colonel Beatty said Captain Acland's results came to the same as his (the lecturer's). If Captain Acland proposed flying 6½ hours in an aeroplane, he thought that was wrong. If one landed half way and renewed the petrol supply the carrying capacity was increased. Colonel Beatty said he (the lecturer) wanted speed and did not get it, but he thought 110 miles an hour cruising speed was enough for the present. The machine would actually do about 121. It was necessary to do at least 110 miles an hour on a regular service regularly to be able to compete with the weather. Speeds above 110 miles an hour were governed by the question of competition with the trains and boats. He could see a time when they would have to run 140 to 150 miles an hour with the mails. There were three typical aeroplanes designed for the Napier Lion engine—one did 145 miles an hour and carried 400lbs., one did 120 miles an hour and carried a ton, and a third only on paper did 80 miles an hour and carried 2½ tons. When one had to compete with the telegraph one might have to fly 145 miles an hour, but when one had to fly say from Blantyre to Fort Jameson and carry tobacco that speed was not necessary, but one could not fly much slower than 75 miles an hour. At that speed 2½ tons could be carried, and it began to be worth while to carry tobacco. The speed required depended upon what one wanted to do. He hoped he had made it clear that in his opinion the one basic factor was that one must fly 110 miles for a regular service, but outside that various speeds could be adopted to comply with varying conditions. Colonel Beatty wanted to compromise; the Government always wanted to compromise. He could not see any reason for the amphibian. It meant carrying a lot of apparatus that one would not want to use except in most unusual circumstances. The only excuse for the flying boat was for flying where one could not get an aerodrome and could get water to alight on. A big flying boat, perhaps carrying 100 passengers, would, he thought, be the vehicle for crossing the Atlantic, but that was a long way ahead. Colonel Beatty referred to his estimate of cost of spares as being too high. He had been pessimistic right through, and tried to make his figures big. He put the spares high because if he started to-morrow he would have to buy the spares and could not get them except by paying for them. With regard to the figure of £45,000 for annual expenditure on the ground, most people whom he had tried to get interested from a financial point of view thought the figure too low. He thought it was about right. Sir Alan Anderson did not think the figures reliable. He (the lecturer) hated figures, and only produced them because people demanded them. The financial man would not back such a proposition unless the details were put down in black and white. He claimed that in aviation one could get nearer to the cost and profits than in ships and railways. There were more uncertain factors in a new shipping line or new railway than in a new aerial transport line. There was no wear and tear on the track, there were terminal stations to fly to and from, and it was easier to get down to bedrock facts as to the cost. The one unknown factor seemed to be the load, which depended on the service being reliable. One advantage of heavier-than-air services was the ability to use small units. The Government were taking on a lot of the

expense with regard to the provision of aerodromes, weather reporting and so on, which decreased the capital expenditure necessary. That £45,000 would be necessary for running one machine a day, but six machines—three each way—could be run every day without extra expense on these heads. On the Constantinople-Karachi route more machines could be put on certain parts of the route and less on others. For instance, from Basra to Baghdad the traffic might be heavy; from Mosul to Aleppo it might be thin; and again from Bunder Abbas to Karachi it might be heavy; units could be shifted about to adapt the service on any one stage to the traffic on that stage. That was why he had always been an advocate of the small aeroplane in these early stages of development. It was the most economical means of carrying the small load available. The big machine would come in later when the new trade had really established itself.

Squadron Leader WIMPERIS moved a vote of thanks to the Chairman, and said the Government, in taking charge of aviation, needed someone to act as pilot and navigator for the whole scheme, and they were well placed in having Sir F. H. Sykes in that position.

CORRESPONDENCE.

To the Editor of the AERONAUTICAL JOURNAL.

DEAR SIR,—I have been very interested in reading the discussion on Major C. F. Abell's paper on "Airship Machinery; Past Experience and Future Requirements," more particularly with reference to the various types of prime movers suggested for use in the propulsion of airships. I should like to say a word in favour of the steam plant. One of the speakers in the discussion (Wing-Commander Cave-Browne-Cave) gave some comparative figures of the fuel consumption of the modern internal combustion aero engine and the steam power plant. Taking the fuel consumption of the modern aero engine as .5lb. per b.h.p. hour, the comparative figure for a steam plant is given by Wing-Commander Cave-Browne-Cave as .85lb. per b.h.p. hour as a minimum estimate. I should be interested to know upon what basis this figure is obtained. It seems to me to be a very high estimate if considered as "at the most optimistic estimate." Perhaps the following rather approximate figures may be interesting, as showing what can be done with the modern steam automobile. The powers developed are necessarily much smaller than those employed for airship work.

There are two modern makes of steam automobile—the Stanley and the Doble. The former is rated at 20 horse power, but it is capable of a continuous output of double this rating, whilst for a short period it will deliver 80 horse power. This car will steam at 40 m.p.h. on the level continuously and keep 500lbs. of steam in the gauge all the time. For a short period it will "sprint" up to between 60 and 70 m.p.h. The complete weight of the car with 5-seater open body is 32cwt. The engine is a simple, double-acting two-cylinder, of bore 4in. × 5in. stroke. The boiler is of the vertical fire tube type, 23in. in diameter and 14in. deep. The consumption of paraffin is about 14 miles per gallon. Thus at 28 m.p.h. the fuel consumed is two gallons per hour, which is roughly equivalent to 16lbs. of fuel per hour. At this speed—28 m.p.h.—the engine is delivering probably in excess of 32 b.h.p., which gives 0.5lb. of fuel per horse power per hour. This figure is the same as for the best aero engines. A condenser, or radiator, is fitted to the car enabling it to travel a distance of from 200 to 400 miles in one filling of the 25-gallon water tank, depending upon conditions of running.

The Doble steam car has an engine of the run-flow type, two-cylinder, double-acting, single expansion, stroke 4in. × bore 5in. The boiler is of the semi-flash water tube type. The fuel is paraffin. The rating of this car is given as 75 horse power, and it is capable of maintaining a speed of some 60 m.p.h. on the level continuously. A condensing system for the water is employed as in the Stanley car. The weight of the car is 2 tons. The fuel consumption is from 9 to 10 miles per American gallon. The car will accelerate from rest to 30 m.p.h. in 5 seconds. The above figures compare, as in the case of the Stanley steam car, very favourably with the best aero engine practice.

It seems to me that the possibilities of steam compare more favourably than is usually supposed with the best performance of the present type of the internal combustion aero engine. There are other obvious advantages of the steam plant as applied to airship work. The question of propeller speed (r.p.m.) is much more favourable to the steam system than to the I.C.E. system, because slow r.p.m. means greater efficiency and the utilisation of larger propeller diameters than otherwise possible. I am not considering here constructional difficulties between the two types; this is doubtless an important aspect of the question also.

The fact that the steam plant is going to return for automobile use raises the question whether or no it may not also usefully be employed for aircraft work, particularly airships. The previous difficulty of water consumption should be able to be overcome by the use of an efficient condensing system, as employed on the Stanley and Doble steam cars.

The fact that enlightened engineers have at last begun to realise that the I.C.E. is, for use in an automobile, at best nothing but a complex example of misplaced ingenuity, leads one to hope that possibly in other directions also the steam plant may prove its superiority over the existing type. The case of the airship seems to be a likely opportunity for this hope to be realised.

I am,

Yours, etc.,

M. A. S. RIACH.

REVIEWS.

Applied Aerodynamics. G. P. Thomson, M.A. Hodder and Stoughton, Ltd. £2 2s. net.

Aerodynamics is an experimental science, and all design work connected with it must of necessity be founded upon results obtained by experiment. The realisation of this necessity has led to the foundation of the large research departments at the National Physical Laboratory and the Royal Aircraft Establishment as well as to a number of smaller but quite efficient departments in connection with aircraft firms.

The output from the national departments during the war was immense, and any who were in touch with this work and who had to apply the results to design will appreciate the real need that exists for a marshalling of the data into some sort of order.

For one particular line of research Mr. Thomson has attempted this, and the result is the very useful book under review. Divided into two parts, the first deals with performance while the second is given over to stability.

The first chapter consists of a general outline, and contains a number of brief discussions on such varied problems as stability, strength, and special aspects of flight. One would like to see rather more attention paid to exact wording in some instances, *e.g.*, it comes rather as a surprise to find an aeroplane wing structure described as a mechanism (p. 16).

The next two chapters deal with the physical theory and methods used in experimental research. These are very useful as a general resumé, but we would suggest might profitably be extended somewhat in a future edition.

Chapter IV. is really a summary of the experimental knowledge gained on the resistance of wires and struts, and forms a valuable reference chapter. The reference to the Barling and Webb tapered strut requires expansion, or else it should be omitted. A meridian curve of a general nature is shown, which is said to be on the safe side, but since no indication of the strength of such a strut is given Figure 40 is of no value.

Chapter V. on wing structure discusses some of the problems arising in the main plane design. This chapter is of great interest although some of the statements made are debatable, *e.g.*, the author states that stagger is determined by stability consideration. This may be correct in some cases, but one imagines that the original and primary reason for staggering the planes was to improve the view and to obtain increased aerodynamic efficiency.

The notes on variable camber wings do not seem quite complete. We presume the reference to tests is to those upon an aeroplane built at the R.A.E., but we would remind Mr. Thompson that quite successful results were obtained by Mr. C. R. Fairey on a seaplane and we believe Mr. R. A. Bruce of the Westland Aircraft works also designed a small seaplane with adjustable flaps.

Chapter VI. is a good outline of the work done on resistances of bodies and fuselages and contains such information as is available as to interference effects of one part of the structure on the others, as well as a note on slip stream effect.

Chapter VII. on landing gears and miscellaneous resistances is not very satisfying, and one would like much fuller information than is contained in its two pages.

Chapter VIII. on airscrews furnishes an outline of the theories of design, and should be of value as an introduction to a more detailed study.

Chapter IX. is called "The Large Aeroplane," and we must say we are disappointed. It consists of only two pages of letterpress of the most general nature, and one feels that it would have been better to leave it out if this is all the writer has to say on such an important problem. Incidentally the reference on p. 128 should be to figure 80 not 81.

Chapter X. on prediction of performance completes the first part of the volume. It contains such information as the designer will require in his work, and is very well illustrated by an actual example.

The second half of the book deals with stability and is a very good account of the work done on this important subject.

Naturally it contains the mathematical work rendered familiar (by sight at least) to all readers of the A.C.A. reports, but in addition, and this will interest the designer more, a good discussion of such effects as downwash and of experimental work on control surfaces. The chapter on controllability is of considerable interest, particularly as ideas on this important subject are so vague.

One fervently hopes that the day will soon come when some genius will evolve drawing office methods which will enable the questions of stability and control to be met fairly by the engineer. At present the mathematics scares him and the experimental results necessary are not always easily obtainable. In consequence aeroplanes may or may not have any stability—it is largely a matter of chance.

Simple methods are required, but not of the type given on p. 216 for longitudinal stability, where the author suggests "An aeroplane of ordinary type will probably be stable if it has a tail of about the usual size and if its centre of gravity lies within the front third of the effective chord."

This is frankly ridiculous, and we think Mr. Thomson knows it. Even the most hardened "rule-of-thumb" engineer would not be satisfied and would want a few numerical constants properly tabulated in his pocket book of formulæ.

The book is a useful one for the designer and will also serve as a good introduction and guide to the student who desires to study carefully the large amount of work which has been done.

The general production is excellent, but the figures in many cases require redrawing. The lettering on them is often slovenly and in many cases somewhat difficult to read.

Lieutenant-Colonel O'Gorman contributes an introduction.

Complete Aeronautics. Edited by Clarence Winchester. Vol. I.

This book aims at the instruction of those interested in aeronautics as a science and a career, and it is therefore as a text book for students that it must be considered.

It might be reviewed from a variety of other standpoints, but since the avowed object of the editor is to provide a serious work of this nature one must perforce examine its claims from that point of view. Everyone is entitled to his own opinions, but a teacher of science has a certain responsibility in seeing that his students receive training which will enable them to think clearly and later formulate their own opinions on matters of a controversial nature. Obviously then, a book for the student should deal with matters which are at least proven as far as possible, and pet theories held by the writer in a minority of one or thereabouts should be excluded.

The present work is edited by Mr. Clarence Winchester, and the contributors to the first volume are Mr. Sydney Camm, Captain Douglas Shaw, "an ex-R.A.F. officer" and Mr. E. P. King.

Mr. Camm deals with principles of flight and design, and as long as he keeps to descriptive matter he is quite readable.

When he gets to aerodynamics, however, he is somewhat misleading; a student will have great difficulty in following him, and one is not too sure that he always understands himself.

He uses dimensional coefficients throughout (following Eiffel), but attempts to explain the non-dimensional system in use in this country. How successful he is may be judged from the fact that in the fundamental formula for lift his speed is given in miles per hour, and in order to correct this he uses a value for the mass density of air of .0051 and quotes this as being in miles per hour (p. 49).

Standard symbols are ignored and ρ becomes p. On page 50 p is also used as a pressure intensity, and we get this symbol appearing in the same equation with its two meanings thus—

$$p = CpV^2$$

His description of scale effect shows inadequate appreciation of the point at issue. He infers that it is purely a speed effect, but no mention is made of the dimensions of the model.

His chapters on stability show a somewhat limited appreciation of the difficulties and often a lack of information on experimental results, *e.g.*, the angle of downwash is stated to be generally about 1° less than the angle of incidence of the wings.

His summary of the discussion on longitudinal stability leads to this—"It is to be noted that the conditions of longitudinal stability are fairly well satisfied when the angle between the main and tail surfaces forms a longitudinal dihedral with the main forces acting approximately through the centre of gravity."

The second part of the book, by Captain Douglas Shaw, is devoted to stability, and we think a student will only follow him with difficulty as he does not appear sufficiently clear in his own mind to instruct others, *e.g.*, "The stable machine does not glide as far as the unstable machine (if the latter can glide at all!)" His system of mechanics is of an unusual brand, as may be gathered from the following quotations:—

"The centre of gravity of an aeroplane is virtually a universal joint . . . ."

"A momentary gust of wind may not be sufficient to overcome the inertia of the aeroplane."

"Quantitative inertia without distributive inertia should be a keynote of good design."

"Each of the axes (X, Y, Z) lies wholly in two planes."

"In 99 per cent., if not 100 per cent., of the aeroplanes in use the three axes (x, y, z) are all that are required in consideration of stability."

"The difficulty of defining stability is apparent. . . . . Stability permits of sound explanation but not definition."

In discussing the question of longitudinal stability, considerable space is given relative to the vertical position of the centre of gravity; but the author apparently has missed the point that the fore and aft position is the dominant factor.

"The condition to be complied with in order to maintain inherent longitudinal stability is that the leading surface must be permanently set at a greater effective angle than the rear surface."

We might quote indefinitely, but we think enough has been said to show that Captain Shaw is not quite the man to give the young aeronautical engineer his first lessons in stability.

The aero engine section is a simple outline of the elements of internal combustion engines.

The last section on airscrews by Mr. King is the longest in the book, and far and away the best.

This really is a good exposition of the theory and practice of airscrew design and construction, and will be of considerable value to the student. It is, to our mind, the only section in the book which fulfils the specification laid down by the editor, and we congratulate Mr. King on his contribution.

With this exception we cannot recommend this book. The doubtful views expressed and the evidence of very limited knowledge in fundamentals shown in the two first sections render it emphatically *not* a book for students.

Our remarks have been confined to one aspect of the case—the more experienced man may find a certain interest in reading the work, although we venture to think he will not make use of much of the material contained therein.